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Power Plant of The Wm. Wrigley Co.

SMALL PLANT MODERNLY EQUIPPED. UNIQUE METHOD OF ASH HANDLING AND SMALL STEAM PIPING EMPLOYED

IT IS CLAIMED that the Wm. Wrigley Co. at 35th St. and Ashland Ave., Chicago, has the largest chewing gum factory in the world, and when told that the daily output of the plant running full capacity is approximately 30 tons, or about 6,000,000 sticks of gum, one begins to wonder less what use is made of the boilers, engines, generators, pumps and other auxiliaries with which the plant is equipped.

On entering the engine room, one is immediately impressed by its interior finish and the indirect system of illumination, as well as the machinery layout. The ceiling, upper half of supporting columns, and enameled brick walls are all white—a combination which is conducive to both neatness and efficient lighting. The 2 leading power generating units, as shown in Fig. 1, are placed side by side with ample space all around, while the exciter unit and all the pumps are located along the wall separating the engine and boiler rooms. The

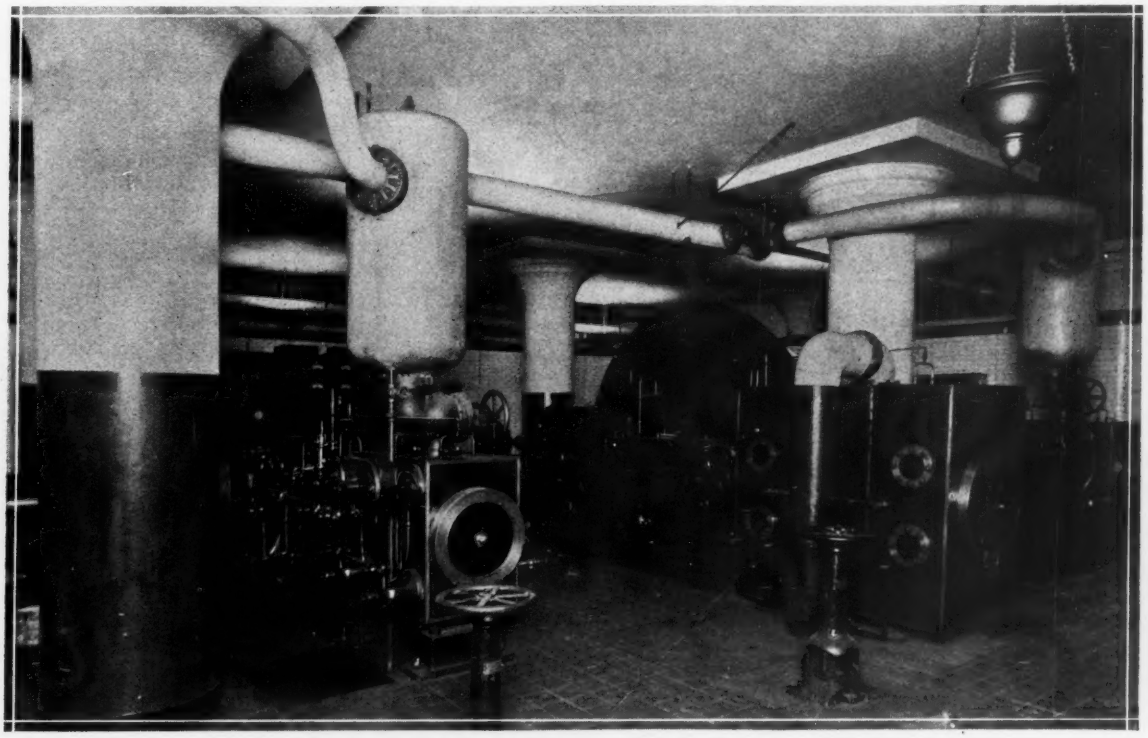


FIG. 1. INTERIOR OF ENGINE ROOM SHOWING 2 MAIN POWER UNITS

switchboard stands near the generator end of the 2 principal power units, liberal space being left between the board and the wall back of it. Nine panels constitute the switchboard, which is modernly equipped and conveniently arranged.

Power Generating Equipment

All 3 of the engines are products of the Ball Engine Co., while the generators and motors were manufactured by the Crocker-Wheeler Co. The main unit consists of a cross-compound 18 and 30 by 27-in. Corliss engine, direct-connected to a 428-k.v.a. generator whose capacity is 1060 amp. at 240 volts, 3 phase, 60 cycles, running at 150 r.p.m. An auxiliary unit, which may be operated in parallel with the larger one or alone on light loads, consists of a simple 15 by 20-in. Corliss engine driving a 150-k.v.a. generator of 360 amp. capacity at 200 r.p.m. In addition to these alternating-current machines, is a 32-kw. exciter, delivering 291 amp. at 110 volts and driven by a 9 by 10-in. engine running at 300 r.p.m.

On these engines the pump and filter system of lubrication is employed, the oil being pumped from a Richardson filter into an overhead gravity tank located in the boiler room. Each engine is provided with a small oil tank mounted on the frame and an oil pump operated from the crankpin.

Alternating current for lighting is furnished by means of the 3-phase, 4-wire system, while for power 3 wires carry the current. Since the voltage between any 2 phases is 220, and between any phase and the neutral is only 127 volts, 3 transformers of small size are employed to step the voltage down to 110 volts.

Continuous current for motors and lighting is supplied by a motor-generator set composed of a 20-kw. generator, delivering current at 110 volts and driven by a 35-hp. motor.

At the head end of the 2 a.c. machines near the wall is located the gage board which carries gages showing the following pressures: steam at the engines; exhaust steam; compressed air; steam in the factory line; water in the sprinkler system; water in the house tank; ice water in the fountain system; and city water. A Bristol recorder makes a continuous graph of the steam pressure. A pneumatic clock operated by the master clock in the main office also has a place on this board.

Steam from the high-pressure cylinder of the compound engine, whose cranks are set at 90 deg., is discharged into a 9-in. pipe which serves as a receiver between the high and low-pressure cylinders. As is seen from the elevation in Fig. 5, this receiver pipe is placed below the engine room floor and is provided with a trap discharging to the bilge pump.

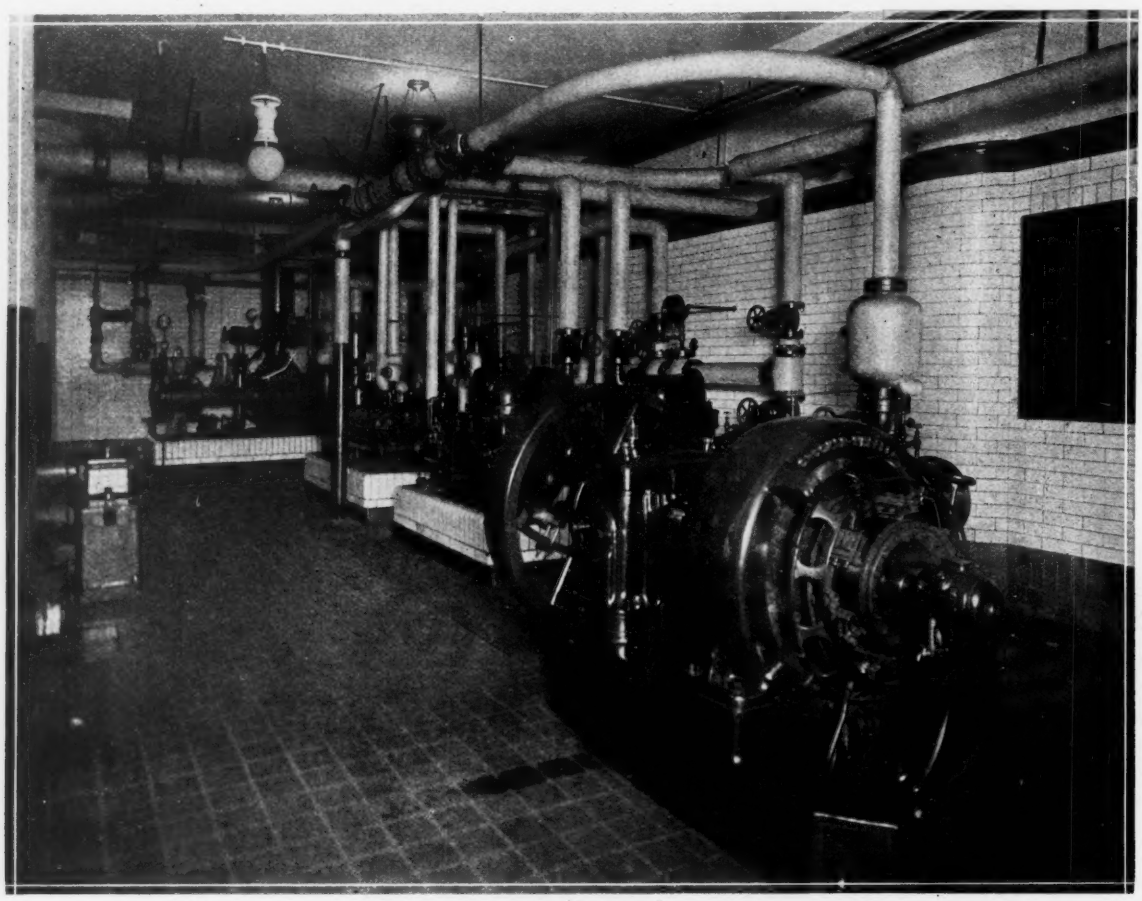


FIG. 2. VIEW OF EXCITER UNIT AND PUMPS IN ENGINE ROOM

As the engines operate noncondensing, because of the lack of condensing water, their exhaust steam, also that from the pumps, is carried to an 18-in. line leading to the feed-water heater, which is of the Cochrane open type. From the oil separator at the heater, a 16-in. atmospheric exhaust line leads to the roof, terminating in an exhaust head, and from this line 2 10-in. pipe lines supply steam to the heating system. During the summer months, when no heat is required, all the surplus exhaust steam above that required for feed-water heating is discharged to atmosphere.

With this arrangement of boilers, that is, 1 rated at 350 hp. and 2 rated at 250 hp. each, it is possible to meet almost any load condition which is likely to arise and at the same time operate economically, allowing one boiler to be out of service for cleaning. At certain times during the summer, the load may be light enough to be carried by a single small unit, or the 350-hp. unit may be required. In the winter time during severe weather, both the 250-hp. units may be necessary or even the 350-hp. and a 250-hp. unit together.

Each boiler is equipped with a Blonck efficiency

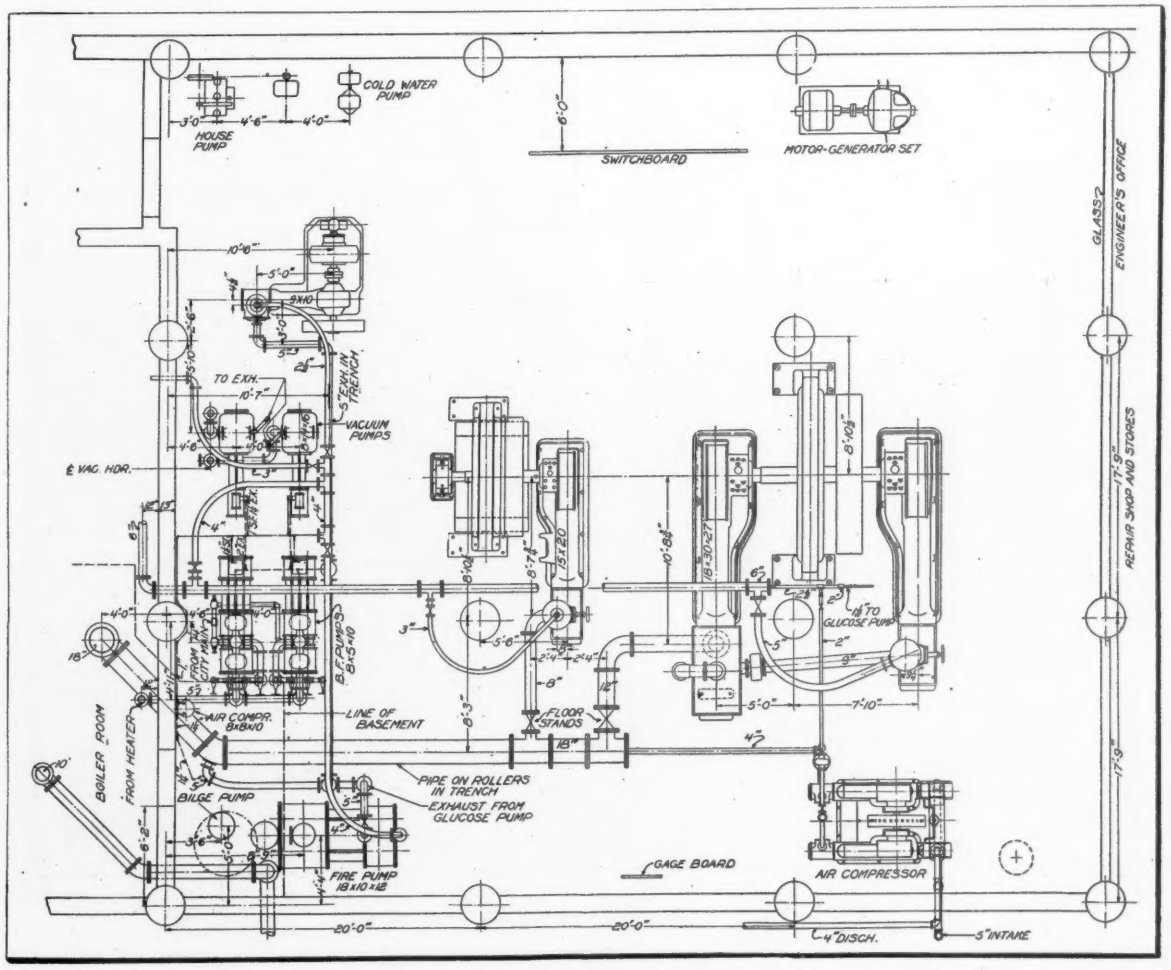


FIG. 3. PLAN OF ENGINE ROOM PIPING

Boilers and Pumps

Steam at 125 lb. pressure is generated by 3 Babcock and Wilcox water-tube boilers, 2 of which are rated at 250 hp. each and 1 at 350 hp. The boilers are equipped with Green chain grate stokers and the coal, consisting of screenings, is shoveled into the hoppers by hand. As the boiler room floor line is about 10 ft. below grade, coal is dumped from the cars directly into a bin, 20 ft. wide by 6 ft. 6 in. high, which extends along in front of the boilers for a distance of 180 ft. This bin will hold about 500 tons of coal, ample storage space thus being provided for emergency.

meter which serves as a guide in firing by indicating the existing draft conditions, such as too little or too much air, overload or underload, and dirty tubes. Draft is automatically controlled by a Lawrence damper regulator which is operated by steam pressure. In order to determine accurately the thoroughness of combustion, a Hays apparatus is employed for analyzing the flue gases.

One of the principal features of the plant is the method of handling and disposing of the ashes. These are removed from the pits and shoveled into a small car that can be pushed along on a track in front of the ash-pit doors in the ash tunnel. At one end of the track,

this car is dumped so that the ashes pass through a grating and are carried by a bucket elevator, Fig. 8, up to a large bin, 12 ft. long by 8 ft. wide and 22 ft. high. When enough ashes have accumulated in the bin to fill a car, they are dumped into an empty car from which coal has just been unloaded. In this manner the ashes are removed in full carload lots.

As shown by Fig. 8, this ash bin is located inside a 6-story building and extends from the second to the fourth floor. The bin is of fireproof construction, with walls of concrete 6 in. thick, so that it is unnecessary to wet down the ashes in order to be protected against fire. The elevator that hoists the ashes is operated through a spur gear and pinion by a 5-hp. induction motor.

Feed water at a temperature of about 210 deg. F. is supplied to the boilers by duplicate 8 by 5 by 10-in. Snow duplex pumps, any excess over that supplied by the returns from heating system, drips, and traps being taken from the city mains. Condensation from the heating system is returned by duplicate 8 by 14 by 16-in. Knowles vacuum pumps. After leaving the heater, the boiler feed passes through a Cochrane meter where a continuous record is made by a Lea V-notch recorder showing the pounds of water fed to the boilers per hour.

To keep the boilers free from scale, about 8 lb. of soda ash is used for each 10,000 lb. of water evaporated. In Fig. 7 may be seen the chemical tank from which the compound is forced by air pressure into the heater.

The bilge pump can be operated by either a d.c. or a.c. motor as desired, the d.c. being held in reserve during the day and used at night. Hot and cold water for house use is supplied by a 3-crank pump chain-driven from a 5-hp. motor running at 1130 r.p.m. Ice water for drinking purposes is circulated by a Yeomans centrif-

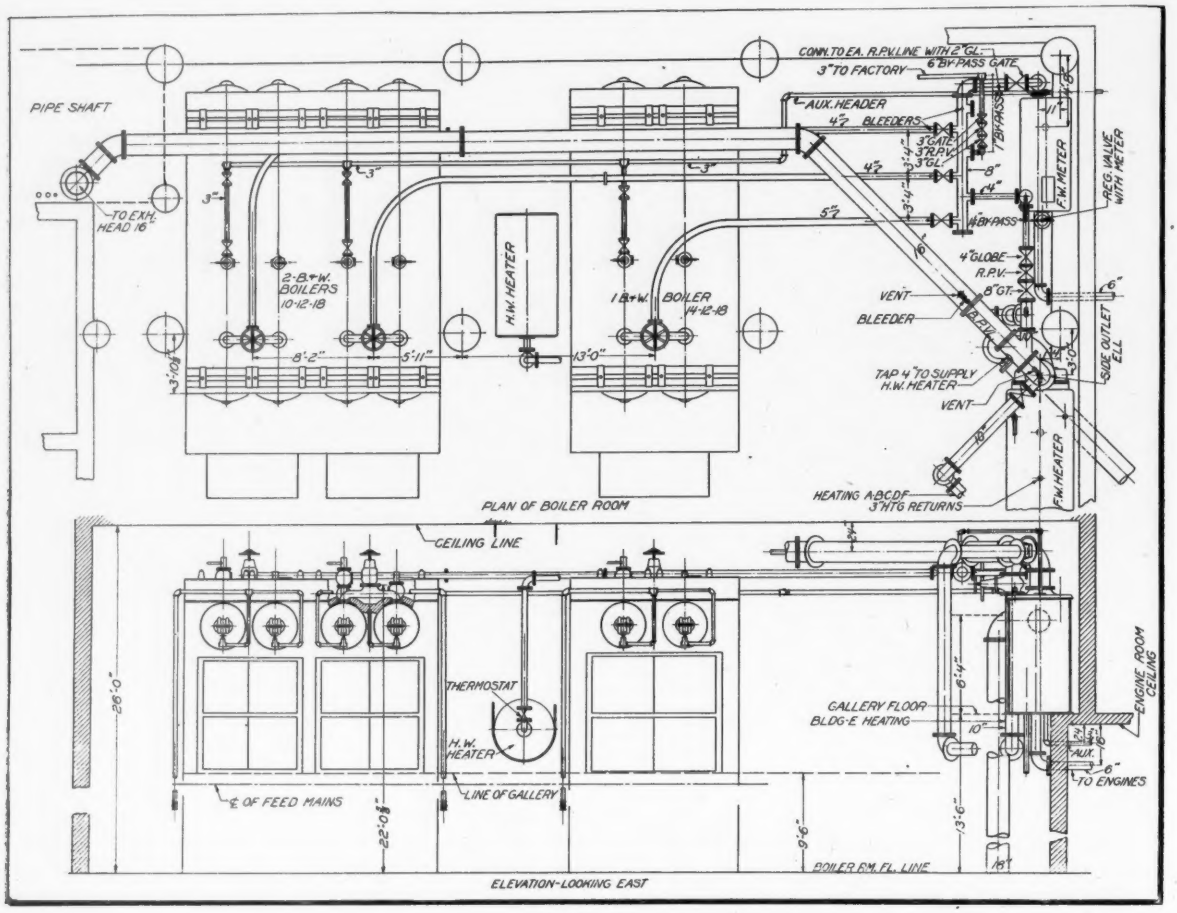


FIG. 4. PLAN AND ELEVATION OF BOILER ROOM PIPING

ugal pump driven by a 2-hp. motor. In addition to the sprinkler system for fire protection, a Knowles duplex 18 by 10 by 12-in. fire pump is provided.

At the present time compressed air at 90 lb. pressure is supplied by an 8 by 8 by 10-in. Westinghouse air brake pump, but a 2-stage Ingersoll-Rand compressor with a capacity of 327 cu. ft. of free air per minute is being installed, which besides furnishing air for the machine shop and for cleaning generators and motors, will supply the considerable quantity necessary for blowing out vats or kettles and in handling glucose.

Piping

No feature of this plant stands out more prominently than does the small size of steam piping,

which is characteristic of plants designed by W. L. Fergus & Co. The advantage accruing from the use of small piping and, consequently, the transmission of steam through piping at a high linear velocity is two-

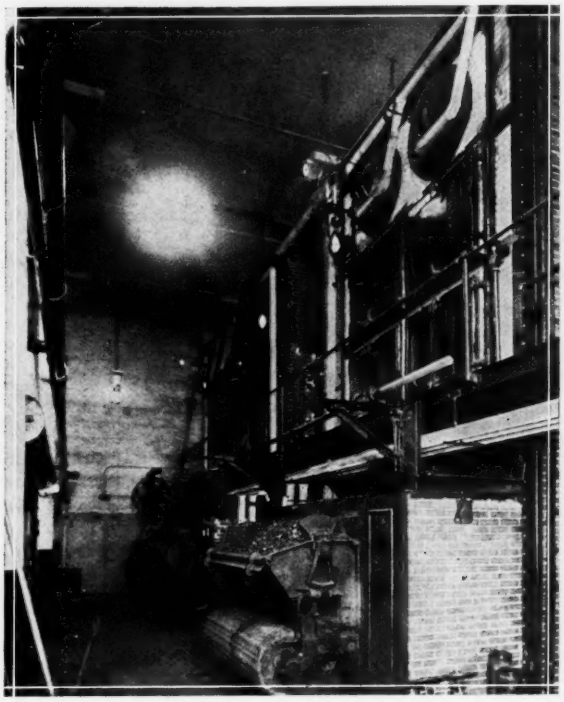


FIG. 6. FRONT VIEW OF BOILERS

fold: First, the condensation loss is reduced on account of the smaller amount of pipe surface in proportion to the weight of steam carried, and because of the fact that the steam, when moving at a high rate of speed, has less time in which to condense than would be the case with larger piping; second, the cost of piping and covering is less with the small diameter.

Piping to these engines is designed to give a maximum steam velocity of about 10,000 ft. per minute under normal conditions. The significance of this figure becomes apparent when the fact is considered that 6000 ft. per minute is common in engineering practice.

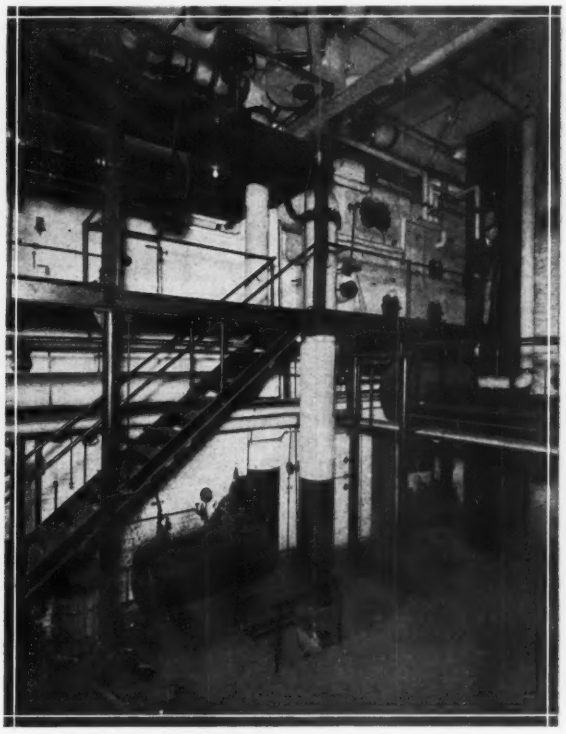


FIG. 7. GALLERY ARRANGEMENT IN BOILER ROOM, LOOKING TOWARD ENGINE ROOM. SHOWS FEED WATER HEATER AND METER, ASH HOIST, ETC.

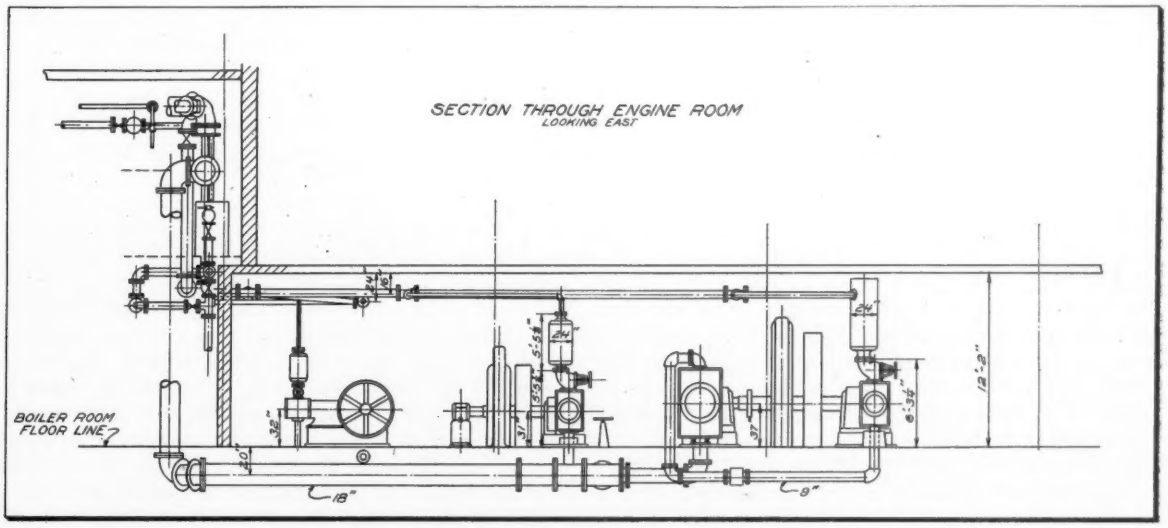


FIG. 5. ELEVATION OF ENGINE ROOM PIPING

To prevent pulsating effect in the small piping, due to intermittent draft of steam by the engines, receiver separators of large size are used at the engines. The separator at the larger engine is 2 ft. in diameter by 6 ft.

long, while the smaller one is 2 ft. by 4 ft., giving sufficient volume to produce a uniform flow of steam in the piping.

Steam from the smaller boilers is piped to the main header by 2 4-in. lines, while a 5-in. line is used from the largest boiler. The main header is 8 in. in diameter and is cast in one piece. Leading from this header is a 6-in. pipe, supplying steam to the engines and pumps,

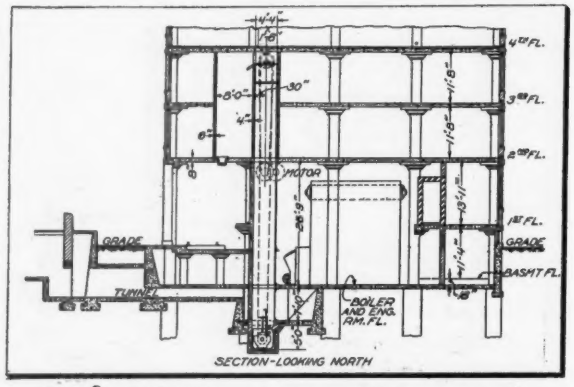


FIG. 8. ELEVATION OF ASH HOIST AND ASH BIN

the compound engine receiving its steam through a 5-in. line, the simple engine through a 3-in. line, while the exciter engine and pumps are supplied by a 4-in. line, and a glucose pump out in the factory requires a 1½-in. line. Also a 4-in. line takes steam from the main header, supplying live steam to the factory through a 3-in. line and to the heating system by a 4-in. line, the latter being used at times when sufficient exhaust steam is not available. Owing to the high temperatures required in the manufacturing process, the exhaust steam cannot be used for this purpose. A temperature corresponding to a steam pressure of about 50 or 60 lb. is generally required.

For emergency use a 3-in. auxiliary line is provided for the exciter engine and pumps, also the heating system. The steam drums of each boiler are equipped with duplicate safety valves attached above a tee connection, and steam for this auxiliary line can be taken from a tee outlet of each boiler below one of the safety valves.

Factory Power

Of the electrical power consumed in the process of manufacture, about 150 hp. is required for mixing the gum, 100 hp. is needed for pulverizing sugar, and 50 hp. is used for wrapping purposes. In addition, there is a variable amount of power used for lighting and for the operation of elevators. As there are 3 elevators, each operated by a 35-hp. motor, and a fourth by a 15-hp. motor, it is obvious that the elevator load may, at times, be sufficient to cause a material lowering of the voltage. The small all night load, consisting principally of stair lights for the 6 buildings, besides the boiler and engine room lights, is carried by the exciter unity.

This plant has been in operation about 8 months and is a good example of a small modern, well designed plant.

Installation of Economizers

The Value of Economizers and Types of Layouts. By Warren H. Miller

STUDY OF any collection of economizer layouts will show that, as a rule, neither architect nor consulting engineer have been sufficiently posted as to the practical operating and maintenance needs of the economizer. In too many cases does it appear that the designer has not "been there" himself, has not actually put up economizers, run them himself, superintended the periodic job of cleaning them, repaired tubes, scrapers and scraper mechanism, and in a word has not shown by his design any consideration for the man who will have to do these things, year in and year out, as part of his daily work. As the architect and the electrical engineer are the ones most apt to be short on practical experience with such a special piece of apparatus as the economizer, this paper will aim to give a general idea of the practical operating conditions which must be provided for in its installation, the relation it must bear to chimney and boiler flue, its connections with the feed water system, the blowoff main, etc.

The economizer is an innocent-looking piece of apparatus; to the casual eye it is merely a nest of cast-iron pipes, offering no unusual difficulties in working it into the boiler house design; yet its effect on the total layout, the size and placement of chimneys, the arrangement of the uptake flues is so great that it must receive the most careful planning. It cannot be worked in anywhere, at the last moment, as an afterthought; as its presence will materially alter any boiler house design into which it is introduced. While for small plants the economizer is of doubtful utility, no engineer would think of omitting it in any plant over 500 hp. (provided, of course, the owner could afford one), for its saving of 6 per cent on the coal pile is absolutely undisputed and it will pay for itself in 2 years' time, plus all the expenses of upkeep and repairs.

The logical course, then, is to accept the economizer as a money-making factor in the boiler house equipment, and so to install it as to reduce to a minimum the expenses of taking care of it. Let us then first get an idea of what we have to provide for. An economizer consists of a number of sections of cast-iron tubes, expanded into cast-iron top and bottom headers, and having soot scrapers constantly moving up and down the outside of the tubes, actuated by gearing for the purpose. It is therefore, in a sense, a machine, something that must be kept running; it is also, in a sense, a water-tube boiler, something that has boiler pressure on it all the time, has to be cleaned and scaled just like a boiler, and has tube caps and gaskets, just like a boiler, only more of them. The uptake gases from the boilers pass slowly around the pipes of the economizer on their way to the chimney, giving the feed water a rise of about 60 deg. F. (70 is the maximum to be hoped for) with hot-well temperatures of say 140 deg., and the evaporation gains

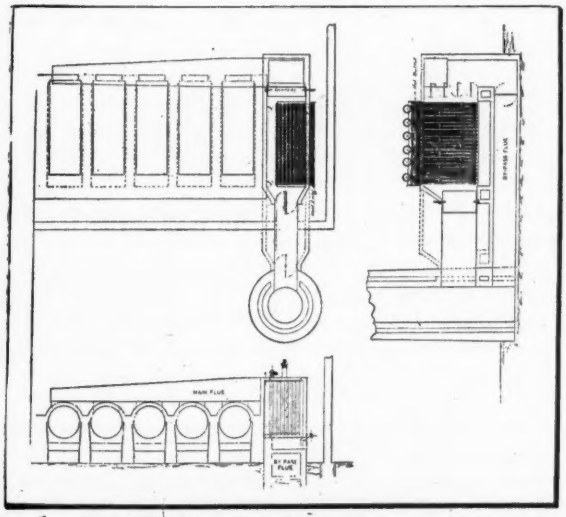


FIG. 1. ARRANGEMENT OF ECONOMIZERS APPLIED TO HORIZONTAL RETURN-TUBULAR BOILERS

0.1 per cent for every degree rise in the feed water, whence the saving of 6 per cent in your coal pile.

Whenever the economizer is shut down, its damper doors must be closed at both ends and the chimney gases led around by another flue. As it is essential to get at the economizer tubes to calk leaks, renew gaskets and clean off scale cakes from leaks, it must be accessible from both sides; this is generally provided for by sectional coverings of sheet iron and asbestos bolted along one side, leaving a space of some 16 in. on the other side between the economizer tubes and the brick wall, which space is normally shut off by cast-iron shutters called "deflectors." The economizer is heavy and bulky, requiring a massive foundation and lots of room. Its sections weigh from 400 lb. up, taking 9 in. of wall length per section. They come 8, 10 and 12 tubes wide, 8 in. center to center of tubes, and the tubes are 10 ft. tall, or 12 ft. over all, height including headers. The scraper mechanism is itself 3 ft. high and requires at least 6 ft. of head room over it, preferably 10 ft., for taking out tubes and getting down a tube scale bar. Finally, as the scrapers send down a continuous shower of soot, this must be caught in some sort of basin which should also have an outside drain to the works sewer to carry off scale sludge. The soot itself must be hoed out through cast-iron doors in the foundation, as the basin fills up about once a month.

We now have a cheerful array of conditions to meet in designing a satisfactory economizer layout. We must provide for a strong, heavy foundation; some sort of a short and economical flue design to collect the chimney gases and pass them through the economizer or bypass them to the chimneys at will; light, air, and space is needed above the economizer to care for the scraper

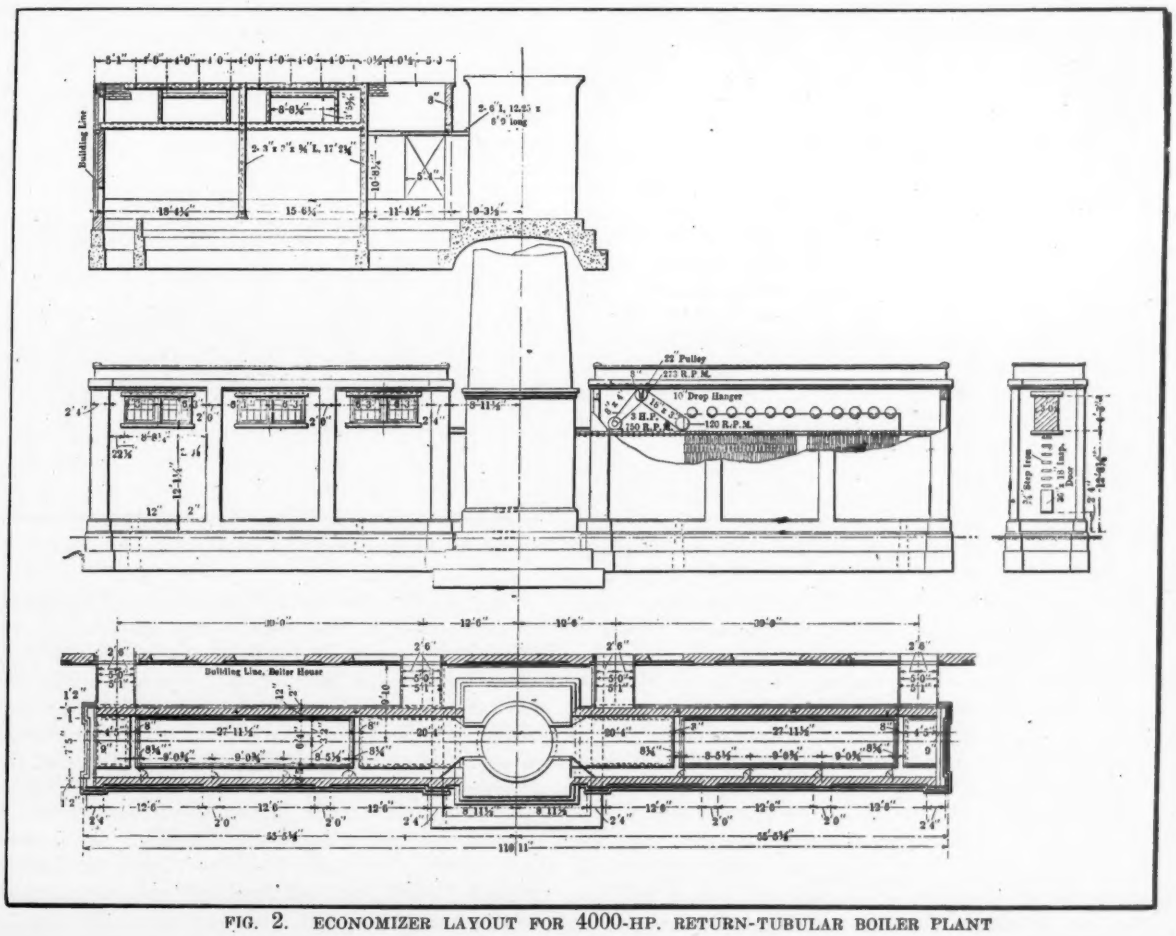


FIG. 2. ECONOMIZER LAYOUT FOR 4000-HP. RETURN-TUBULAR BOILER PLANT

gear, to clean tubes and to take out one occasionally; motive power, of from 1 to 3 hp., must be provided for with belting and shafting for it; piping from your feed-water heater to your economizer and from it to the boiler feed checks must be laid out, with a bypass so as to feed direct into the boilers when necessary; and, finally, a soot basin under the economizer with doors in it and room enough in front of them to work a hoe;

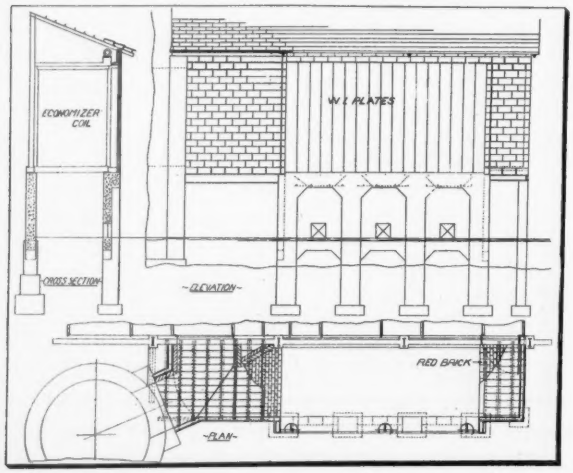


FIG. 3. ECONOMIZERS IN LEAN-TO "THE WORLD'S WORST ECONOMIZER LAYOUT"

a drainage basin or gutter to carry away mud, scale and water when the economizer is being cleaned; and an independent blowoff line to the works drainage system.

TYPES OF ECONOMIZER LAYOUTS

IN GENERAL, there are 3 main types of economizer layouts which have developed from their respective types of power plant. The first and most flexible is the isolated industrial works power plant, usually a one-story structure, spread over considerable ground. The second is the big electric light and power station of 2 or more stories in height, restricted as to ground space yet turning out many thousand of horsepower economically, the design following the judicious use of the various stories in the height of the building. The third type is the city office building and department store power plant, where both ground space and height are exceedingly restricted and the economizer has to be worked in wherever possible.

In all of them the first and most important consideration is the flue layout. Uptake flues quickly grow to enormous size if a battery of boilers all add their quota in one direction on the way to the chimney. Even if keeping down the flue size by running the uptakes towards each other to a central main, the size is such as to require the shortest possible connection to the economizer and bypass under or around it. Wherefore the problem begins with the best location of the economizer in relation to the flues. With horizontal return-tubular boilers the difficulties are further complicated by the fact that the uptakes *must* start from the boiler front and on top; with water-tube boilers the waste gases may be taken out at the back, bottom, or top after the final reverse of the gases over the baffle walls.

Take first the case of the horizontal fire-tube boiler. The simplest layout for a works power plant would be the one shown in Fig. 1, where a battery of 5 100-hp. boilers have their uptakes entering the main flue in succession and the economizer is placed at the end, parallel to the boiler setting, with the bypass flue under it and formed by the foundation walls, the earth and the floor of the soot pan. This is a simple and economical arrangement, for a small plant where the flue does not get to excessive size. Future extension is provided for by beginning the second battery of boilers beyond the economizer and feeding towards it, while extension of the economizer itself can be effected by adding to its length and extending its side walls in the direction of the main chimney. All our other requirements are nicely met with this design; the main boiler house roof over all gives plenty of light, air and head room, and the concrete floor of the boiler house, if properly pitched and drained around the economizer foundations, will carry off cleaning water and mud and scale chips while cleaning. The space behind the boilers, which ought to be free to get at blowoff and back connections, is also left open to window light and fresh air by this design. In a word, it is an infinitely better location than the usual one indulged in by those who do not understand the practical requirements of the economizer and insist on poking it up under the roof, in behind the boilers, where it not only has no working head room itself but shuts out all air and light from the boiler blowoff line and back connections.

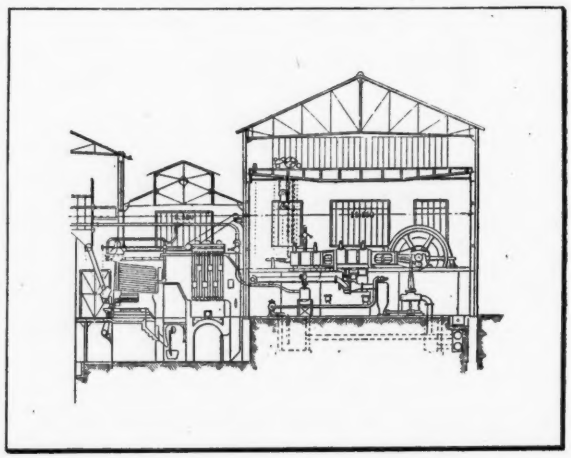


FIG. 4. EUROPEAN PRACTICE IN ECONOMIZER INSTALLATION

In a large return-tubular boiler plant this layout will not do, because the flue areas become too unwieldy, there is usually some sort of a forced draft and pinhole grate system to provide for, and all the space on the boiler line must be used for boilers only because of the coal trestle or other type of coal feed. In the 10,000-hp. boiler house of the Standard Oil Co. at Bayway, N. J., designed some time ago by the writer, 32 250-hp. fire-tube boilers formed the preliminary layout, with a like number to be added on future extension. At the end of the present boiler house, I put the blowers for the underground pinhole grate air feed and also the pumphouse serving the whole plant.

The boilers were arranged, 16 on a side, in batteries of 4 in a setting, with a coal trestle running down the center of the boiler house and an ash tunnel running along underground in front of each line of boilers. A manhole in front of each fire-door provided a way to hoe the ashes down into dump cars below after wetting down. To get the chimney gases away from the boiler fronts I ran square flues between each pair of boilers with a breeching connecting the fronts of each pair. A horizontal butterfly damper in each boiler connection inside the breeching permitted shutting off any boiler that was down and being cleaned, without disturbing its mate. These flues ran into a square main flue, hung from the roof trusses over the back alley behind the boilers, and yet the rear windows gave plenty of light and air so that men could work at the boiler blowoff main, the equalizer connections and the back soot doors.

There is always more or less work going on behind the boilers in a large plant. At least one boiler is down and being cleaned in the natural order of things, and there is usually a valve seat to grind in or a leaky fitting to look after somewhere on the blowoff line (which I always run in plain sight above the concrete floor). Putting the economizers up against the back wall shuts out all air and light and makes work in that long, dark tunnel behind the boilers an inferno, even when well lighted with incandescents—which is seldom done.

I solved the economizer location problem in this plant by putting them *outside*, on opposite sides of the chimneys, as shown in Fig. 2. The wall on the deflector side was of brick, of the same architecture as the rest of the boiler house, and the side with the sectional coverings faced the boiler house. On this side the housing was carried up in corrugated iron with swing windows, and on the outer side the brick wall, with its pilasters and caps had a corresponding set of windows, which with their concrete sills and lintels, made a handsome appearance, in keeping with the rest of the boiler house. The head room chosen was 6 ft., necessitating the use of hydraulic tube cleaners with hose connection; but, as the roof was of reinforced concrete, we counted on punching a hole through it in the event of having to take out a pipe. The main flue went inside the boiler house, swung from the roof trusses, and not coming down far enough to shut off too much of the light. Where the flues pierced the boiler house wall and crossed to the economizer I lagged them with asbestos and reinforced concrete metal lath plaster, pitching a slight gable in the concrete over the top of the flues.

Each economizer was of 1000-hp. capacity and was run by a 3-hp., 3-phase, 440-volt, induction motor, thrown direct on the line. The layout gave us a light, airy economizer housing, making cleaning and upkeep easy, and the space behind the boilers was light and cool so that we had quick work on cleaning boilers and practically no trouble in the upkeep of blowoff cocks, valves and fittings, and the same proved so of the equalizer fixtures. For night work, incandescents, spaced 20 ft. apart, gave ample light.

As might be expected, I had some trouble in convincing the General Manager that putting the economizers outside was the most economical scheme. He wanted them backed up against the boiler house wall, as has been done in many plants, but when we got into the cost of a combined fire and red brick wall, plus the cost of protecting our steel work with fire brick around column pilasters, and filling in between, it was easy to see that windows in that boiler house wall were enough cheaper to more than pay for the extra economizer wall required by putting the latter outside. We made this wall in plain red brick, for, unless the wall forms part of the main building and encloses steel work, I have never found the flue gas temperature in the economizer enough to require a facing of fire brick. Thus, our boiler plant was spared the handicap of a hot, dark tunnel in behind the boilers and the miseries of cleaning and caring for economizers with their tops poked up in some cubby hole under the roof.

With water-tube boilers you have more flexibility in flue connections; but, to my mind, the necessity for light and air behind the boilers is even greater than with the fire-tube type. You have all the tube caps to take off, scrape and replace when cleaning boilers, and after the job is done they must all be tight and show no leaks under hydraulic pressure; there are twice as many blowoff fittings to look after, and if the place is

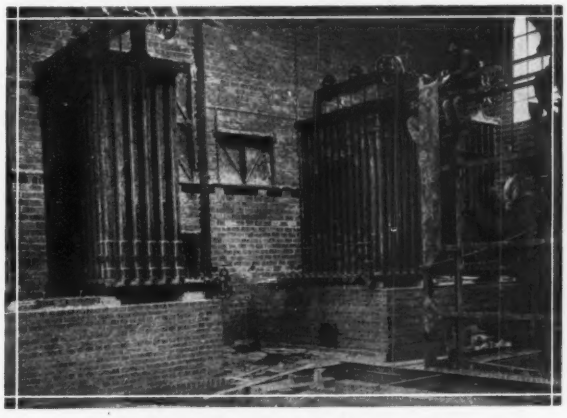


FIG. 5. ECONOMIZER INSTALLATION AT CITY OF PARIS GAS WORKS

dark as a pocket and hot as the infernal regions, these things are going to be neglected and half done. In my first boiler house of this type the general manager was a headstrong man and had already made up his mind, hard and fast, just where the economizer was to go. His plan had the bottom headers projecting through the boiler house wall, with a whole panel of brickwork built on them, and the outer ends of the headers rested on a 20-in. concrete foundation. The sectional coverings went on this side and the roof of the boiler house extended over the economizer tops with just stooping room over the gears, a cubby hole where, as I explained to him, the temperature would never be much less than 160 deg. F. Luckily the boiler house roof was of tile, so that when this precious design finally emerged in iron and steel and we put boiler pressure on it, we were able to run, clean and repair it by the simple expedient of taking off the roof. I show a print of this design in Fig. 3 and label it the World's Worst Economizer Layout, claiming no parentage therein. It has all the bad points there are. Note, however, the flue connections; I was able to run a main flue having but 2 boilers area

yet taking care of all 4 boilers, either direct to the chimney or reverse to the economizer, by taking advantage of the fact that the length of an economizer is but one-half that of the battery of boilers it serves. In another plant I put the economizer outside, with the main flue hung from the roof of the boiler house trusses and the several connections entering it from below with soot doors to trap off the accumulated soot and ash. It is essential to put a soot door somewhere within hoeing distance of every damper in the main flue, or else the soot and ash will pile in drifts and no amount of force can then budge the dampers, so that you cannot shut off the economizer to get at it.

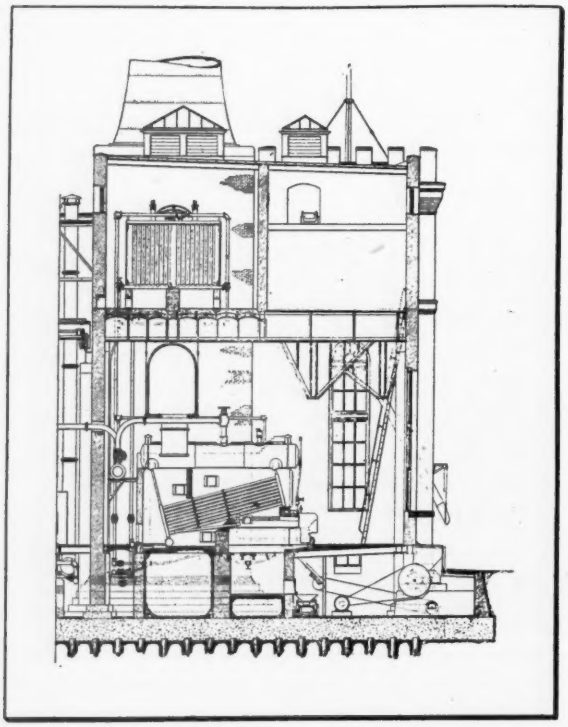


FIG. 6. ECONOMIZER LOCATION IN CENTRAL STATION OF THE WASHINGTON (D. C.) STREET RAILWAYS

Figure 4 shows European practice with the economizer, in connection with water-tube boilers. This particular design is in the city of Paris gas plant at Landy, France. The economizer is set in the same brickwork as the boiler, in behind it, on the same level, with a baffle wall in between. The gases pass over the tubes sidewise instead of lengthwise of the economizer, as with us, shoot down along the back wall of the boiler setting and into the main chimney flue under the economizer, which flue is formed by its foundation walls and the bottom of the soot pan.

This arrangement is not to be sniffed at. It is logical, and typically French in its exact economy. Nothing is wasted; there are no bypass flues, no sectional coverings, no extra foundations, and no special economizer housing. When a boiler shuts down, its economizer goes with it, so both can be cleaned at once without disturbing the rest of the plant. There is plenty of room inside the flue on both sides of the economizer to inspect tubes, free stuck scrapers, etc., and, by lifting the cast-iron plate which forms the top of the flue, light and air are admitted to those working at the rear caps when the boiler is being cleaned. By this design, the overhead problems are also simplified, for the same roof truss that covers the boilers also takes in the economizer tops, and 6 or even 10 ft. of head room are available without any special adjustment of the general design, since at least 6 ft. of head room is needed over the boilers for good pipe main design. This arrangement requires a wide economizer to develop the full temperature rise from the flue gases; French practice finds 12 tubes wide sufficient, which happens to be one of our widest stock sizes.

(To be continued)

Diesel Engines at the Panama-Pacific Exposition

IT is announced by the Department of Machinery of the Panama-Pacific International Exposition that since Jan. 1, of this year, more than 30,000 sq. ft. of exhibit space has been contracted for in the Palace of Machinery.

Intense interest is taken in the new Diesel Marine Engine, with which the "Siam," the largest motor ship in the world, now lying at the wharf in San Francisco, is equipped. More than a dozen large firms have contracted for space in which to install engines built on the Diesel principle. These exhibits will occupy a central space in the great Palace of Machinery, and will be in operation connected to electric generators or other machinery for the purpose of showing the efficiency and economy of working.

A large amount of exhibit space in the Palace of Machinery has also been spoken for by the manufacturers of steam turbines and unit type plants, the latter consisting of compact boiler, superheaters and engines. In the electrical department will be demonstrated the latest apparatus for the transmission and control of electric currents at voltages up to 1,000,000.

AT A RECENT MEETING in Shanghai of the Saturday Club, Mr. T. H. U. Aldridge, the Shanghai municipal electrical engineer, made an address which deals with the equipping of Chinese cities, large and small, with electric power and lighting plants, and which may be of live interest to American electric supply houses. Mr. Aldridge tells how the Chinese, especially in the interior, desiring a plant, go to work to get it. Within a few years some hundreds of communities will take on electric plants—a score have already done so—and electric equipment houses of a number of nations have elaborate showrooms in Shanghai and other treaty ports, and their agents, who are trained electrical engineers, are busy traveling from community to community to secure orders. (A printed copy of the address in question will be loaned on application to the Bureau of Foreign and Domestic Commerce.)

Bonus In The Power Plant

RESULTS OF ITS APPLICATION IN ONE INSTANCE. BY WALTER N. POLAKOV

THOSE who have had anything to do with the manufacture of power know, and do not hesitate to say, that the firemen can play the dickens with the cost of production; and they do.

It seems to be also a consensus of opinion that the firemen should be better educated; but they are not.

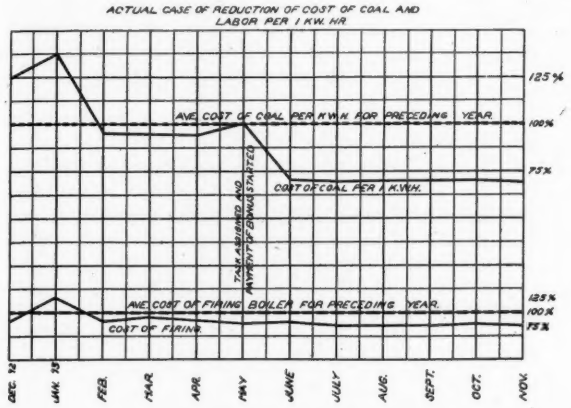


FIG. 1. REDUCTION IN COST OF POWER FROM IMPROVED METHODS

Average management prefers to hire ready-made firemen and let them play the dickens with the cost. When the cost goes too high the officers of the company go up in the air. They put the blame on the superintendent. He puts the blame on the firemen. And,—they continue to fire just as they have from the habit of years.

Students of the question know how to obtain high thermal efficiency and it is once in a while attained during a specially arranged test; but this high thermal efficiency is not always the most economical, just as high carbon dioxide not always indicates good boiler efficiency.

What we are after is *cost* of power.

In Fig. 1 we see an example of a reduction of cost; both cost of fuel and cost of labor. Throughout the entire record we had the same price of coal, the same boilers and furnaces, the same equipment, same men and the same superintendent.

What was the cause, then? We gained knowledge. We analyzed the situation in most minute detail. We installed records and store-keeping and care of upkeep.

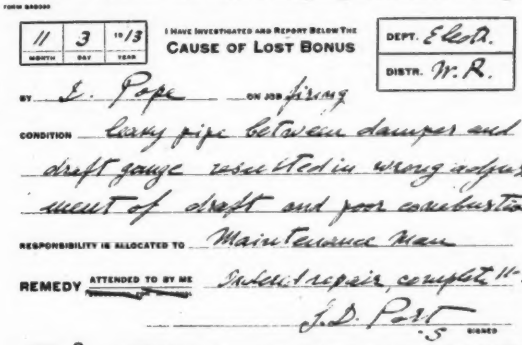

11 | 3 | 13
MONTH | DAY | YEAR
I HAVE INVESTIGATED AND REPORT BELOW THE
CAUSE OF LOST BONUS
DEPT. Elect.
DISTR. W. R.
BY L. Pope ON JOB firing
CONDITION Dirty pipe between damper and draft gauge resulted in wrong adjustment of draft and poor combustion
RESPONSIBILITY IS ALLOCATED TO Maintenance Man
REMEDY ATTENDED TO BY ME Intended repair complete 11-3-13
J.D. Pole
SIGNED

FIG. 2. REPORT SLIP ON FAILURE TO EARN BONUS

We learned what and how the fireman must do; and we assumed the responsibility of teaching and guiding him in his work.

We donned overalls and worked and experimented in the boiler house day in and day out, until we were ready to tell to the men: "Here is your standard. We know that you *cannot* do it and therefore we do not blame you for not doing it before. But we also know that you *will* do it if you are willing to learn. We will teach you, and those who learn will get a reward."

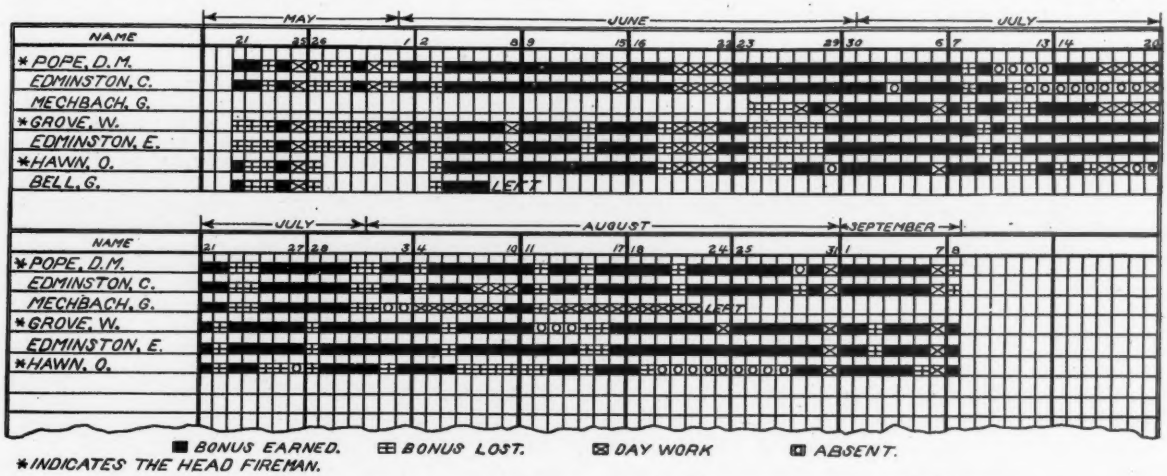
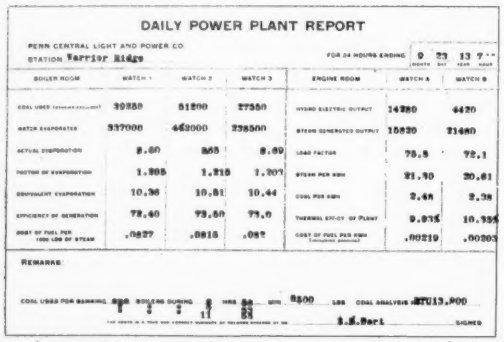


FIG. 3. RECORD OF DAYS WHEN BONUS WAS EARNED, SHOWING IMPROVEMENT WITH TEACHING

And we taught them for weeks and months, forming new habits. Their work lost monotony; it became a sport; 54 per cent efficiency is forgotten, 72 and 73 per cent is the daily record; 11 tons per man to shovel each shift is no longer needed; 8 tons do the work.

A detailed Instruction Card took the place of the old habits and these cards tell plainly when and what to do.

At any variation of condition of load they know ahead of time at what moment and into which furnace door to throw coal and how much. They know what


DAILY POWER PLANT REPORT

PENN CENTRAL LIGHT AND POWER CO.
STATION Warrior Ridge
FOR 24 HOURS ENDING 9 23 13 7 A.M.

BOILER ROOM	WATCH 1	WATCH 2	WATCH 3	ENGINE ROOM	WATCH A	WATCH B	WATCH C
COAL USED	39250	51200	27550	HYDRO ELECTRIC OUTPUT	14280	4420	4580
WATER EVAPORATED	337000	442000	238500	STEAM GENERATED OUTPUT	15820	21480	11120
ACTUAL EVAPORATION	8.60	8.65	8.69	LOAD FACTOR	75.5	72.1	80.0
FACTOR OF EVAPORATION	1.205	1.218	1.207	STEAM PER KWH	21.30	20.61	21.45
EQUIVALENT EVAPORATION	10.36	10.51	10.44	COAL PER KWH	2.48	2.38	2.48
EFFICIENCY OF GENERATION	72.40	73.50	73.0	THERMAL EFF-CY OF PLANT	9.91%	10.38%	9.94%
COST OF FUEL PER 1000 LBS OF STEAM	.0827	.0815	.082	COST OF FUEL PER KWH	.00219	.00203	.00248

REMARKS:

COAL USED FOR BANKING ... BOILERS DURING ... HRS ... MIN. 8500 LBS. COAL ANALYSIS BTU 13,900

S.S.Burt SIGNED

FIG. 4. REPORT OF POWER PLANT SEPARATED INTO WATCHES

force of draft is needed at any minute. They know what load they will carry on their boilers 10 or 15 min. before it rises or drops. And, above all, at any time they know whether they are living up to the standard.

When, however, a man does something wrong or conditions are such that he falls short of his standard, we do not blame him. The little slip, Fig. 2, tells us and tells the man what was wrong. It cannot be filled out without a careful investigation, and this investigation is made *immediately,* otherwise it cannot be made at all. So, when the man comes again to work, the cause of failure is known and, if possible, eliminated or else we show him how to eliminate it.

"Post mortem" statements are sometimes interesting but always useless. The records we keep are continuous and therefore not filed away without being looked at, but are used continually.

When the man comes back to work he looks at this chart, Fig. 3, and he feels proud and satisfied, seeing against his name on yesterday's date, a "bonus earned" mark. The results of the management's work is also reflected on this chart. The results of training men to better habits are seen by steady increase of bonus earners. Bonus is paid to the Station Superintendent on each man earning his individual bonus, and the superintendent's bonus is doubled if all the men earn their bonus. This is a strong incentive for him to help the poorer fireman by encouraging and teaching him how to do better work.

The system has perpetuated itself, and what formerly was possible under test condition only, has been for the last year a daily average.

Heating and Ventilating Large Buildings

HOT WATER SUPPLY. BY CHARLES L. HUBBARD

WHILE the hot water supply in a large building is not strictly a detail of the heating system, it is usually classed with this part of the equipment, and will therefore be treated briefly in the present series of articles.

The quantity of hot water required will of course vary widely with the size and type of building.

In an office building the amount used is comparatively small, being simply for lavatory purposes, and the requirements are fairly uniform throughout the day, with something of an increase around the lunch hour and also at closing time, which can easily be provided for in the storage capacity of the tank; 2 gal. of hot water per occupant per day would seem to be ample for buildings of this class.

In large hotels the supply must be much greater, as here, baths, kitchen requirements, and laundry work must be provided for. The heaviest draft for baths will vary somewhat with the season of the year, but may be taken as 7 to 9 o'clock in the winter and perhaps half an hour earlier in the summer. In cases of this kind it is customary to count on 20 to 25 gal. of hot water per bath, and 3 per hour for each public bath room, and one bath for the private rooms during the rising period. Kitchen requirements will come largely after this, and a hot-water equipment of sufficient capacity to care for the bath rooms will usually supply the kitchen without difficulty during the remainder of the day, together with any surplus needed for lavatories, etc. The supply for laundry work must, in general, be taken up separately, and the requirements be reduced to gallons per hour for the periods during which the laundry is in use, and must therefore be worked out in each special case. Often this can be timed to avoid the bathing hours so the capacity of the equipment need not be increased on this account.

The next step is to determine the quantity of steam required to heat a given amount of water. Assuming the final temperature of the water to be 180 deg., with an initial temperature of 45 deg. in the mains in the winter, it will call for a rise of $180 - 45 = 135$ deg., requiring $8.3 \times 135 = 1120$ thermal units per gallon of water heated.

The latent heat of steam at atmospheric pressure is 966, therefore $1120 \div 966 = 1.16$ lb. of steam are required for each gallon of water heated.

The amount of steam coil surface in the heater may be based on the assumption that each square foot will condense 0.155 lb. of steam for each degree difference between the average temperature of the water and that of the steam. Taking the conditions noted above, we have average temperature of water $= \frac{180 + 45}{2} = 112$ deg., and temperature of steam at atmospheric pressure, 212 deg., making the weight of steam condensed per square foot of coil surface $(212 - 112) \times 0.155 = 15.5$ lb. per hr. Hence, for these conditions, the weight of steam required per hour for heating the water divided by 15.5 will give the square feet of surface required in

the steam coil. Example: A building requires a maximum of 2000 gal. of hot water per hour; how many pounds of steam at atmospheric pressure will be required to heat it from 45 to 180 deg., and how much coil surface will be necessary? Solution: $2000 \times 1.16 = 2320$ lb. of steam, and $2320 \div 15.5 = 149$ sq. ft. of coil surface.

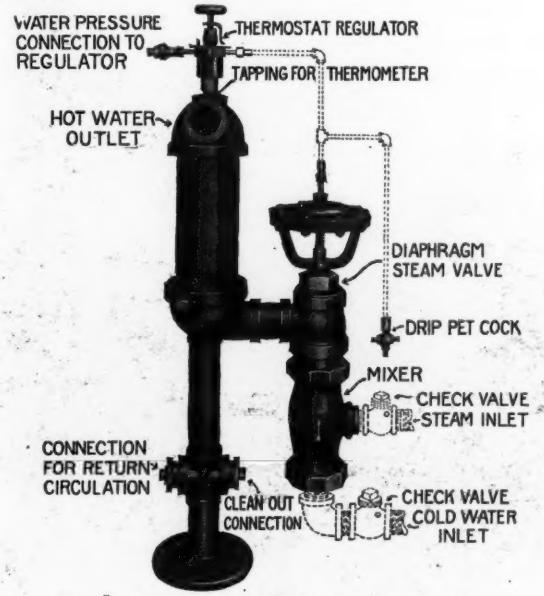


FIG. 3. WELD LIVE STEAM WATER HEATER

The water heating equipment of a large building usually consists of a storage tank, containing a steam coil, and provided with some form of automatic device for regulating the temperature of the water. The size of the tank will depend upon various local conditions. In some cases, especially where the demands for hot water are practically constant, a comparatively small tank may be used with a coil large enough to heat the full supply of water as fast as required. In other cases, like a hotel, for instance, where a large quantity of water is needed during a short time in the morning, a tank of large storage capacity is used and the water allowed to heat during the night. It will be seen from the above that the size of tank will depend upon the amount of reserve it is desired to carry for sudden calls, as well as the total amount used during the day.

Table I will be found useful in estimating the capacities of tanks.

TABLE I. CAPACITIES OF CYLINDRICAL TANKS

Diameter of Tank in Inches	Gallons per Foot of Length
18	13
24	23.5
30	36.5
36	52.5
42	72
48	94
54	119
60	147
66	178
72	212

Storage tanks are commonly made of steel plate, with dished heads to give the proper strength. The coil should be either of copper or brass, of the "return bend" form to provide for expansion. Both inlet and outlet to the coil are commonly placed in the same end of the tank, leaving the other free for the location of a manhole. In tanks of small size, say up to 24 or 30 in. in diameter, the head through the coil connections pass is often made flanged, so that both head and coil are removable.

Water Heaters

In addition to the regulation tank and coil described above, there are a number of special heaters upon the market, some of which will be described.

The Patterson tank heater is shown in Fig. 1. The principal feature of this apparatus is the arrangement of the heating surface, which is clearly indicated in the cut. The steam enters a chamber at the bottom of the tank and from here passes through a large number of small brass tubes of such form as to allow for all expansion strains without damage. It will also be noticed that the coil is in the lower part of the tank where the coolest water is, thereby increasing its efficiency.

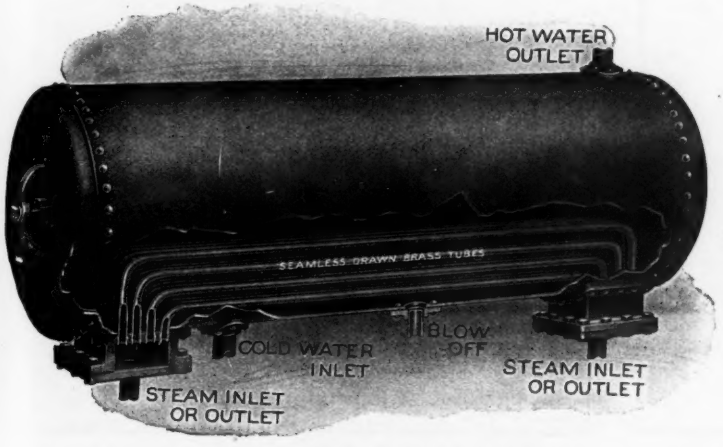


FIG. 1. PATTERSON WATER HEATER

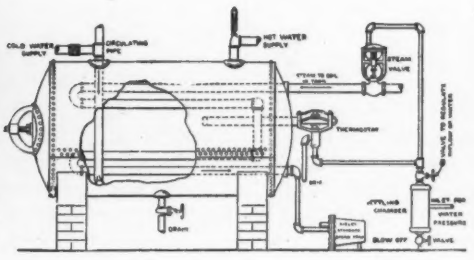


FIG. 2. HEATER PROVIDED WITH RETURN-BEND COIL

Figure 2 shows a tank provided with a return-bend coil and illustrates the method of making the various connections. The automatic controlling device will be described later.

Another type of heater, not shown, contains a large amount of steam heating surface in the form of corrugated copper tubes, and the water is heated as drawn, thus doing away with a large storage tank. The tank heaters previously described are adapted to the use of either live or exhaust steam because the steam and water do not come in direct contact and there is no opportunity for the oil to become mixed with the water.

at the bottom through an automatic diaphragm valve while the cold water enters from the other side, and after mixing, the hot water is forced out at the top of the chamber as noted. No storage tank is required as the water is heated only as needed. The temperature of the water is regulated automatically. When absolute purity of water is not required, as in certain manufacturing processes, exhaust steam may be used after passing it through an efficient oil separator. This heater is espe-

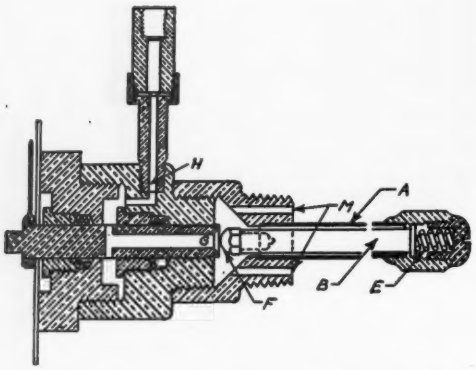


FIG. 4. SECTION THROUGH THERMOSTAT USED IN HOT WATER TANKS

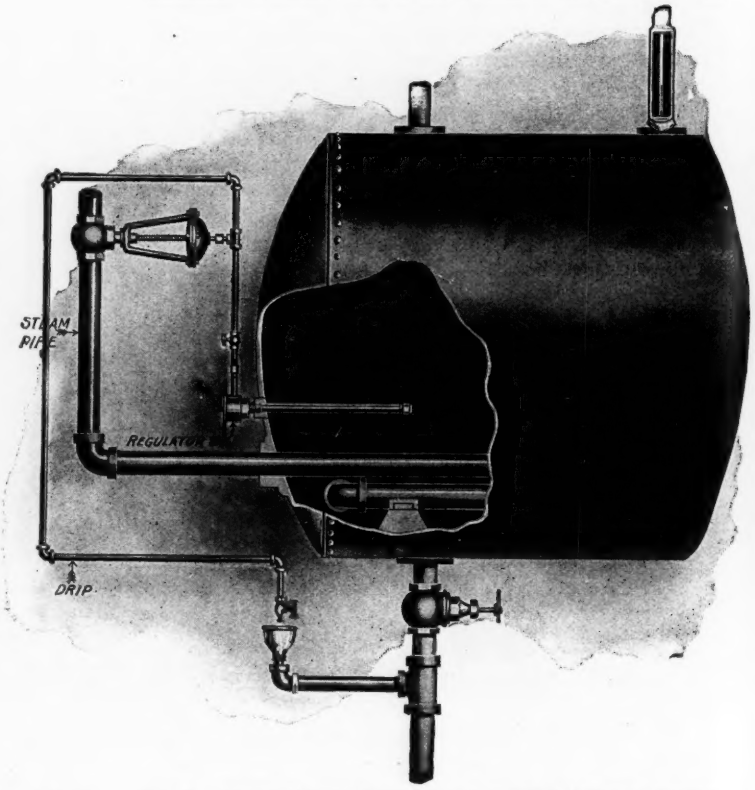


FIG. 5. TEMPERATURE REGULATING SYSTEM FOR HOT WATER TANKS

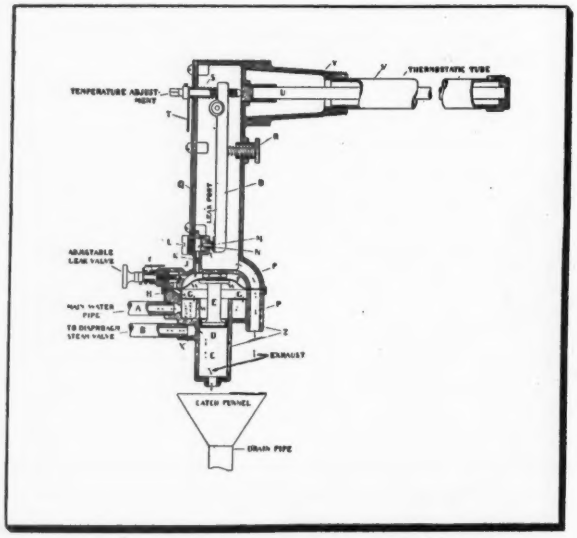


FIG. 6. JOHNSON HYDRAULIC THERMOSTAT

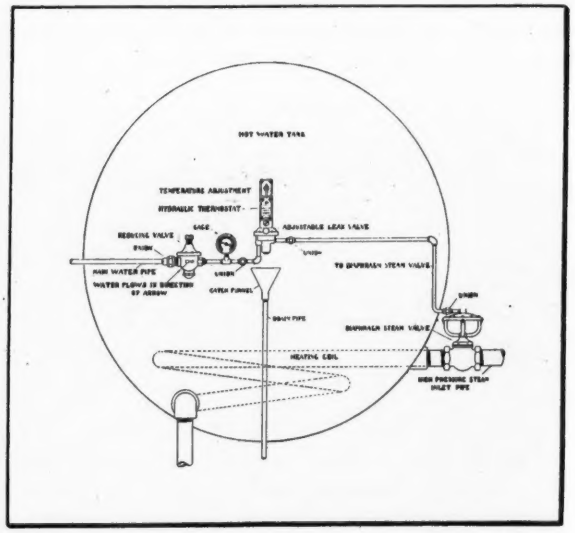


FIG. 7. APPLICATION OF THE HYDRAULIC THERMOSTAT

The Weld heater is of a different type from those shown and is especially adapted to cases where space is limited and only live steam available. In this device the water is heated by direct contact with the steam in a mixing chamber. Referring to the cut, steam enters

cially adapted to cases where large volumes of water are required at intervals.

Temperature Regulation

An important feature of a large hot-water equipment is the automatic regulating device for controlling the temperature of the water.

A typical device of this kind, and its method of operation, are shown in Figs. 4 and 5, which illustrate the Hohman & Maurer automatic regulator. Figure 4 shows a section through the thermostat indicated by Z in Fig. 5. The outer or expansion stem, A, is of brass, and the inner or nonexpanding member, B, is of steel. The stem is inserted in the tank as shown, and when the temperature of the water rises, tube A expands, drawing rod B with it. This action opens valve F, allowing water which comes from the tank under pressure to flow through channels M, G, and H, to the diaphragm valve shown in Fig. 5, thus shutting off the supply of steam to the coil. When the temperature of the water drops below normal, a reverse action takes place, the water

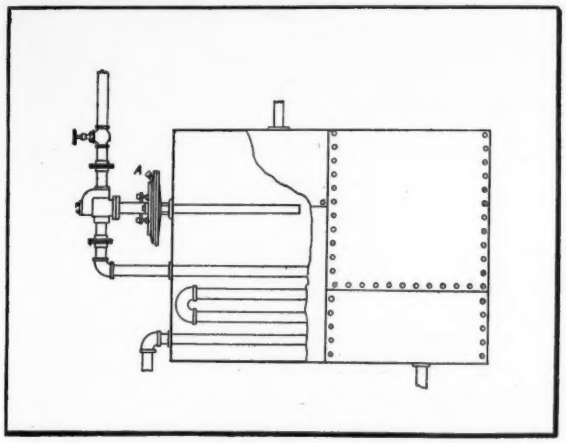


FIG. 8. POWERS THERMOSTAT FOR HOT WATER TANKS

above the diaphragm of the shut-off valve being exhausted through a special drip as shown; the pet cock at the end of the exhaust pipe is adjusted to allow the water to drip slowly all of the time when there is pressure on the diaphragm.

The Johnson hydraulic thermostat is shown in Figs. 6 and 7. This operates on the same general principle as the one just described, but varies somewhat in the details of construction. In this case a glass rod U is used instead of steel, and the water pressure for operating the diaphragm valve is taken from the water main through a special pipe, instead of from the tank. The supply and exhaust for the diaphragm valve take place through the same pipe, the supply and exhaust ports being located within the thermostat and operated by changes in the relative lengths of the glass rod and brass tube. The general method of making the various connections is shown in diagram in Fig. 7.

The Powers regulator, shown in Fig. 8, operates on a somewhat different principle. In this case a rise in temperature of the water above a given point vaporizes a liquid contained in the stem of the thermostat (A), and acts on a diaphragm against atmospheric pressure upon the other side. When the steam valve is less than 2 in. in size, this movement of the diaphragm is transmitted directly to valve stem, thus shutting off the steam supply to the coil.

For larger sizes a special diaphragm steam valve (B, Fig. 9) is employed, and instead of acting directly

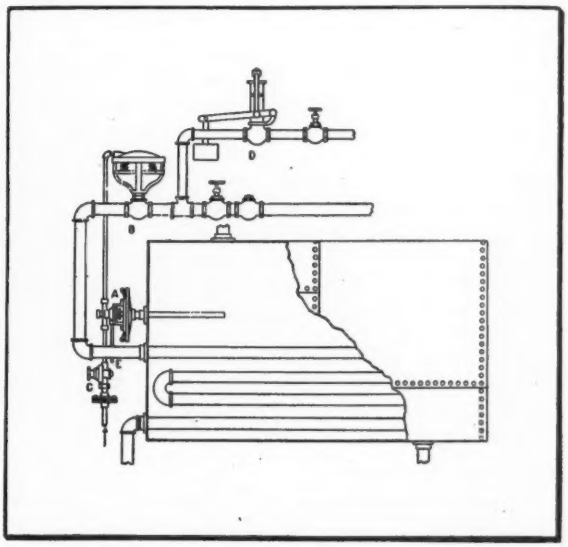


FIG. 9. CONNECTIONS FOR HEATING WATER BY EITHER LIVE OR EXHAUST STEAM OR BOTH

upon this, the thermostat admits water, under pressure, through a reducing valve (C). When the pressure is shut off, the water is exhausted from B through pipe E.

Figure 9 shows connections for heating the water either by live or exhaust steam, or by a combination of the two.

The tank heaters shown in Figs. 2 and 3 are all provided with thermostatic regulators, acting upon the same general principles as those described above.

As a step in forest conservation, a committee of the American Institute of Architects advocated at its recent Convention the creation of a National forest along the banks of the Potomac, Patuxent and Potapsco Rivers near Washington, both to preserve the great natural beauties of the streams and falls and to serve as an experimental and illustrative tract for agricultural and forestation work. This would include some 110,000 acres, of which 60 per cent is now wooded with young growth, and could be secured at an average of $26 an acre. Part of the cleared land would be planted to forests, while that best fitted for farms would be used by the Department of Agriculture for experiment and demonstration.

A standard gage railroad, with all modern appointments, which has been built by the Panama-Pacific International Exposition through its grounds, will provide exhibitors with the quickest and most effective traffic service ever given at an exposition. The cars carry their loads direct to the doors of the various exhibit palaces and in some instances into the buildings. Twelve miles of track is laid, reaching to all quarters of the exposition grounds.

Tests of 4-Pass Boilers With Illinois Coal *

HIGH OVERALL EFFICIENCIES OBTAINED WITH LOW GRADE OF COAL. RADIATION LOSS MINIMIZED BY TIGHT AND WELL INSULATED SETTING. BY BRYANT BANNISTER

IN April of 1913 a new boiler house was completed at the Kewanee Works of National Tube Co., at Kewanee, Ill., and a series of tests, ranging in length from 4 to 24 hr. and with loads varying from 75.6 per cent to 205.2 per cent of rating, were conducted for the purpose, primarily, of proving contract guarantees made by manufacturers upon the equipment installed. Because of some unique features of the installation, together with the fact that a low-grade Illinois coal was burned in the form of 1¼-in. screenings with very high efficiency, it was thought that the results of these tests, 11 in number, would be of value to the engineering world.

		12	
	B.T.U.	%	% Corr.
95 Heat absorbed by Boiler.	8980	80.95	
Net correction to balance correction on items (96)-(102).			-.79
Corrected efficiency.		(80.16)	
96 Loss due to evaporation of moisture in Coal.	231	2.08	
Same, calculated on average moisture in Coal	(194)		
Correction to average moisture			-.33
97 Loss due to heat carried away by Steam formed by burning of hydrogen.	494	4.45	
Correction for items (96)-(97) on basis of corrected stack temperature, from Fig. 3.			-.03
98 Loss due to heat carried away in dry flue gases	855	7.71	
Correction for item (98) on basis of corrected stack Temperature from Fig. 3.			-.21
99 Loss due to carbon monoxide.	35	.31	
Same, average for all tests.	(24)		
Correction to average carbon monoxide			-.10
100 Loss due to combustible in ash and refuse	223	2.01	
Same, average for all tests.	(388)		
Correction to average loss of combustible in ash			1.49
101 102 Loss due to radiation and unaccounted for.	276	2.49	
Correction from Fig. 2			-.03
103 Calorific value of 1 lb. of dry Coal.	11094		
Total.		100.00	0.0

FIG. 1. HEAT BALANCE EVAPORATIVE TEST NO. 12

However, anyone familiar with the Taylor stoker and its thick fuel bed knows how difficult it is to estimate accurately the amount of either coal or ash on the grate, and that the error which might occur in a test of short duration on account of such inaccurate estimate would be of considerable importance. This fact is more apparent when it is considered that 1000 lb. of green coal would be represented by a layer only 2½ in. thick when spread over the surface of a 7-retort stoker, and is also borne out when it is considered that in these 11 tests the weighed ash and refuse was in some instances more than the amount corresponding to the ash in the dry coal consumed plus the combustible in the ash, and in others it was less than this amount. For use in the heat balance for these 11 tests the theoretical amount of ash and refuse was obtained by use of the formula:—

$$\text{Total ash and refuse equals} = \frac{\text{Total dry coal} \times \text{percentage ash in dry coal}}{100 - \text{percentage combustible in dry ash.}}$$

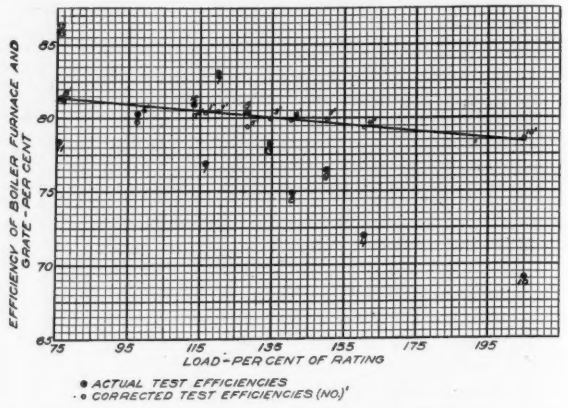


FIG. 2. RELATION BETWEEN COMBINED EFFICIENCY AND LOAD ON BOILER

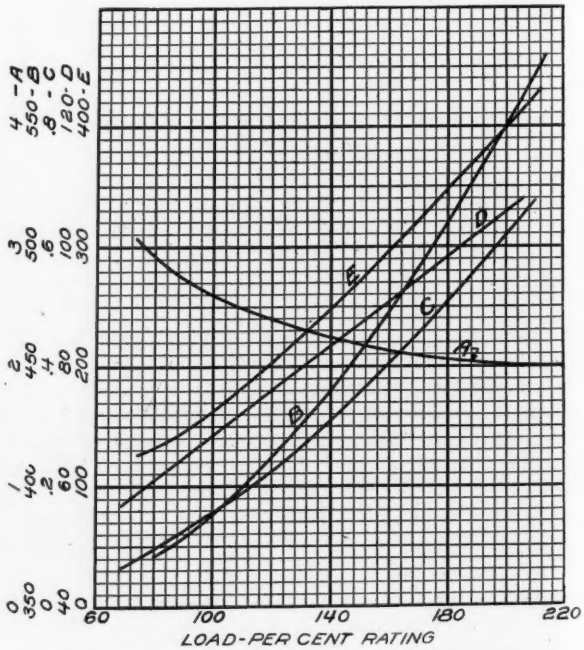


FIG. 3. RELATION BETWEEN LOAD ON BOILER AND (A) RADIATION AND MISCELLANEOUS LOSSES—PER CENT; (B) STACK TEMPERATURES—DEG. F.; (C) LOSS OF DRAFT THROUGH SETTING—IN. OF WATER; (D) SUPERHEAT—DEG. F.; (E) SPEED OF FAN ENGINE—R.P.M.

*From a paper delivered before the Chicago Section of the A. S. M. E., with notes on the discussion which followed.

In order to eliminate, as far as possible, any error arising from the source above mentioned, it has been thought best to conduct a test of much longer duration, so that any error in estimating coal on the grates at beginning and end of test would be spread over a sufficient period to make it comparatively insignificant. No publicity has been given to the results of the first 11 tests heretofore, and the data obtained from these 11

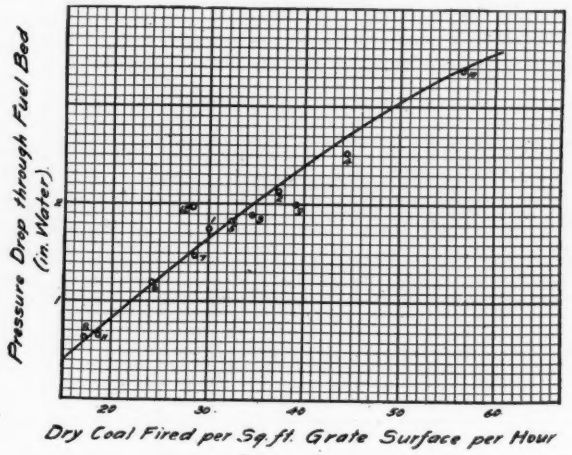


FIG. 4. EFFECT OF RATE OF FIRING ON PRESSURE DROP THROUGH FUEL BED

tests are only given out at this time as corroborated by the results obtained in a 72-hr. test completed October 30, some 6 months after the first 11 tests were made.

The complete boiler plant consists of 4 Edge Moor water tube boilers, each set as a unit, having 20-ft. tubes, and baffles arranged to give 4 passes for the gases, with the stack outlet at the bottom of the fourth pass. Each boiler has 6132 sq. ft. of water-heating surface and 1200 sq. ft. of superheating surface, Foster superheaters being installed. The boiler is set with the bottom of the front header 8.67 ft. above the level of the dumping

The feed water is supplied from a purifying plant and is heated by the exhaust from the auxiliary engines in an open heater. Two turbine driven centrifugal pumps, each having a capacity sufficient for the maximum steam generation, are so piped that any 1 of the 4 boilers may be supplied with feed water by 1 pump, while the other pump supplies the water to the weighing tanks and to the remaining boiler units. Permanent water-weighing equipment has been installed, consisting of 2 scale tanks of 2750 lb. capacity, and 1 supply tank of 4500 lb. capacity.

No. of Test	Proximate Analysis of Coal Dry Coal: Fixed Carbon	Volatile Matter	Ash	B.T.U. per lb. Dry Coal	Ultimate Analysis of Dry Coal: C	H	O	N	S	Ash
1	42.38	35.97	21.65	11325	61.95	4.57	7.76	.99	3.09	21.65
2	41.64	35.97	21.39	11318	62.10	4.60	7.18	1.06	3.67	21.39
3	41.41	42.21	36.05	21.74	11211	59.60	4.50	9.41	.96	3.79	21.74
4	43.10	44.30	36.16	19.54	11298	59.15	4.58			3.34	19.54
5	44.08	43.85	34.98	21.77	11048	58.65	4.67	10.36	1.03	3.32	21.77
6	43.06	43.04	36.55	20.41	11282	59.15	4.58			3.86	20.41
7	45.83			19.54	11335	59.15	4.58				19.54
8	45.51	44.11	36.64	19.25	11408	59.15	4.58			3.43	19.25
9	43.63	42.71	36.66	20.45	11303	59.18	4.58			3.33	20.45
10	45.76	46.56	36.29	17.15	11844	59.15	4.58			3.66	17.15
11	45.77	43.95	36.98	19.07	11598	59.15	4.58			3.17	19.07
12	46.15			19.45	11094	59.15	4.58			3.36	19.45

Note: Made by R. W. Hunt Co., Chicago. Peoria Co. coal used in first 2 tests; Fulton Co. coal in last 10. Total C and H in tests 4 and 6 to 12 taken as average of values for tests 3 and 5.

FIG. 6. COAL ANALYSES

Much was done to make each boiler setting tight and as free from radiation losses as possible. The setting was first painted with a thick asbestos paint, and then covered with 1½-in. coating of 85 per cent magnesia heat insulator, and finally covered with muslin and again painted to insure no air leakage. The boiler headers were also covered, where exposed, with this same magnesia compound, and the whole setting top covered with a 3-in. layer of fire brick and cement, and then with the magnesia covering. At no point during the tests was the setting more than warm, even at the highest loads.

During tests the coal was dropped from a chute into a scale-box of 1000-lb. capacity and carefully weighed, then shoveled into the stoker hopper. From each weigh-

Test No.	Load H.P. By Flow-meter	Load H.P. Actual	Engine Speed R.P.M. Rating	Engine Speed R.P.M. Actual	Blast Press. in Water	Draft in. Water. Furnace	Draft in. Water. Pass.	Draft in. Water. Stack	Temp. Flue Gases °F	Super-Heat. °F	Press. Gage Lbs. per Sq. In.	Feed Water Temp °F	Factor of Evapor.	Flue Gases. CO_2	Flue Gases. O_2	Flue Gases. CO	Flue Gases. Total	Coal. Ash Dry Coal	Coal. Hyd. Dry Coal	Coal. B.T.U. Dry Coal	Coal. Moisture	Carbon in Dry Ash & Refuse %	Equiv. Evapor. per Lb. Coal. As Fired.	Equiv. Evapor. per Lb. Coal. Dry.	Equiv. Evapor. per Sq. Ft. Grate Surface	Equiv. Evapor. per Sq. Ft. Heating Surface	Coal per Boiler H.P. Hour. As Fired	Coal per Boiler H.P. Hour. Dry	Coal Consumed per Sq. Ft. — Meter. Sq. Ft. Grate Surface Dry.	Coal Consumed per Sq. Ft. — Meter. As Fired	Coal Consumed per Sq. Ft. — Meter. Dry	Lbs. Air per Lb. Dry Coal Fired.	Effic. Boiler Furnace & Grate %
1	752	715	117	204	1.69	.042	.230	.0742	404	60.5	112	194	1.0956	12.99	6.13	.07	19.19	21.65	*4.57	11,325	12.81	*13.05	7.82	8.97	.871	3.37	4.42	3.85	30.2	4.51	3.93	11.01	76.87
2	921	861	140	243	2.07	.043	.340	.0764	434	82.5	115	190	1.1123	13.31	5.92	.09	19.32	21.39	*4.60	11,318	11.63	*12.94	7.72	8.74	.926	4.06	4.47	3.85	31.4	5.50	4.96	10.75	74.92
3	910	825	135	230	1.66	.023	.320	.0776	426	63.5	112	189	1.1124	13.03	5.65	.04	18.72	21.74	*4.50	11,211	11.41	*10.84	8.01	9.04	.913	3.86	4.31	3.82	34.6	5.06	4.50	10.74	78.27
4	1056	984	161	300	2.46	.027	.450	.0860	479	80.6	116	185	1.1165	13.91	4.32	.007	18.24	19.54	4.58	11,290	13.10	*12.34	7.28	8.38	.973	4.44	4.74	4.12	44.6	6.66	5.80	10.65	71.96
5	841	784	128	222	1.80	.014	.260	.0806	450	91.2	116	184	1.1231	13.03	5.62	.03	18.66	21.77	*4.67	11,046	14.06	11.01	7.86	9.15	.997	3.69	4.39	3.77	38.5	4.91	4.22	10.57	80.36
6	633	597	97	165	1.17	.026	.190	.0760	421	82.3	114	187	1.1143	12.79	4.95	.18	17.92	20.41	4.58	11,262	13.86	8.71	8.84	9.33	.926	2.81	4.36	3.70	24.2	3.66	3.15	10.97	80.27
7	798	735	120	200	1.45	.025	.240	.0752	419	77.7	116	187	1.1124	13.42	5.12	.02	19.16	19.54	4.58	11,335	15.63	11.66	8.19	9.70	.978	3.46	4.22	3.56	28.7	4.43	3.74	10.31	83.05
8	474	466	76	123	0.68	.031	.104	.0667	359	61.1	112	189	1.1003	13.64	5.20	.10	18.94	19.35	4.58	11,408	15.51	10.40	8.64	10.22	.777	2.19	4.00	3.36	17.3	2.66	2.25	10.17	86.32
9	1023	922	150	273	1.96	.029	.370	.0834	459	84.7	116	190	1.1134	13.86	4.73	.03	18.64	20.45	4.58	11,303	13.63	16.26	7.69	8.91	.950	4.05	4.48	3.87	39.3	5.91	5.11	10.05	76.47
10	1130	1258	205	417	3.31	.056	.700	.0918	510	105.3	123	184	1.1318	14.19	3.99	.025	18.21	17.15	4.58	11,844	15.76	10.98	7.10	8.42	.977	5.98	4.07	4.10	56.6	8.75	7.36	9.95	69.02
11	988	964	156	131	0.63	.012	.087	.0698	376	59.2	112	192	1.0966	13.47	4.99	.01	18.47	19.07	4.58	11,598	15.77	11.12	7.89	9.37	.976	2.18	4.37	3.68	18.6	2.90	2.44	10.39	78.36
Ave.						.030		.0764	431	78.0	115.1	188.3	1.1117	13.42	5.20	.055	18.67	20.18	4.58	11,367	13.93	11.57	7.84	9.11			4.42	3.80				10.45	
														*By Analysis								*From Average.											
12		636	113	225	1.35	.011	.255	0.80	412	77.9	117.6	194.9	1.1049	13.33	5.35	.00	18.76	19.45	4.58	11,094	16.15	6.73	7.76	9.25	2.64	3.28	4.45	3.73	28.5	4.42	3.71	10.66	80.95

FIG. 7. TEST AND COMPUTED RESULTS OF BOILER TRIALS 1 TO 12

plate of the stoker, thus giving the large combustion chamber so essential to the thorough combustion of highly volatile coals. The other furnace dimensions are 12.75 ft. wide by 8.50 ft. deep. The firing is done by a 7-retort Taylor stoker equipped with air extension grate. Each stoker has its own fan and engine.

ing a sample shovelful was taken and the aggregate of these kept in a tight metal box for each 8 hr. run, and then quartered for a sample. Moisture determinations on coal were made by National Tube Co. as soon after the taking of these 8-hr. samples as possible, according to standard laboratory methods. Proximate analyses

NATIONAL TUBE CO. - KEWANEE WORKS.

Data and results of evaporative tests.

1. Tests of Edge Moor Water Tube, four pass Boilers, located at Kewanee, Ill. to determine efficiency and capacity, conducted by National Tube Co.
2. Kind of Furnace. ____ Taylor Stoker.
3. Grate Surface ____ 91 Sq. Ft.
4. Water Heating Surface. ____ 6132 Sq. Ft.
5. Superheating Surface. ____ 1200 Sq. Ft.

		Test "1	Test "2	Test "3	Test "4	Test "5	Test "6	Test "7	Test "8	Test "9	Test "10	Test "11	Test "12
6	Date	4-30-13	5-1-13	5-2-13	5-6-13	5-8-13	5-9-13	5-14-13	5-15-13	5-16-13	5-19-13	5-20-13	10-27 to 30 1913
7	Duration	8 Hrs.	8 Hrs	8 Hrs	8 Hrs	24 Hrs.	8 Hrs.	8 Hrs.	8 Hrs.	8 Hrs.	4 Hrs.	8 Hrs.	72 Hrs.
8	Kind and size of Coal		Illinois		Bituminous			Screenings.					
	AVERAGE PRESSURES AND TEMPERATURES.												
9	Steam Pressure by Gage.	112.1	115.1	112.3	118.5	116.0	113.7	116.0	111.9	115.8	122.9	112.4	117.6
10	Temperature of Feed-Water entering Boiler	193.6	189.6	189.4	186.3	183.9	187.3	187.1	189.4	189.9	184.0	182.1	194.9
11	Temperature of escaping Gases leaving Boiler	404.0	434.3	428.2	479.2	450.1	421.2	418.8	359.0	459.1	510.3	376.1	412.0
12	Draft in Furnace.	.042	.043	.023	.027	.014	.028	.025	.031	.029	.056	.012	.011
	Blast pressure under grate	1.69	2.07	1.86	2.48	1.80	1.17	1.45	.60	1.96	3.31	.83	1.95
13	Degrees of Superheat of Steam.	60.5	82.6	83.5	80.8	81.2	82.3	77.7	61.1	84.7	105.3	59.2	77.9
	TOTAL QUANTITIES.												
14	Weight of Coal as fired.	25241	30767	28411	37329	82569	20489	24783	14901	33085	24471	16228	222,703
15	Percentage of Moisture in Coal.	12.81	11.63	11.41	13.10	14.09	13.86	15.63	15.51	13.63	15.76	15.77	16.15
16	Total weight of dry Coal consumed.	22008	27189	25169	32439	70943	17650	20909	12590	28576	20614	13669	186,736
17	Total ash and Refuse	5480	6680	6137	7231	17355	3946	4625	2705	6816	3971	2933	39,185
18	Percentage of Ash and Refuse in Dry Coal.	24.90	24.57	24.39	22.29	24.48	22.36	22.12	21.49	23.85	19.26	21.46	20.98
19	Total weight of Water fed to Boiler.	180,207	213,538	204,586	243,341	578,050	147,820	182,336	116,993	228,614	153,435	116,740	1,563,910
20	Total weight of water evaporated, corrected for moisture in steam.	180,207	213,538	204,586	243,341	578,050	147,820	182,336	116,993	228,614	153,435	116,740	1,563,910
21	Total equivalent evaporation from and at 212°	197,435	237,585	227,581	271,690	643,206	164,716	202,831	129,661	254,539	173,658	129,017	1,727,964
	HOURLY QUANTITIES & RATES.												
22	Dry Coal consumed per hr.	2751	3399	3146	4055	2956	2206	2614	1574	3572	5154	1709	2594
23	Dry Coal consumed per sq. ft. of grate surface per hr.	30.2	37.4	34.6	44.6	32.5	24.2	28.7	17.3	39.3	56.6	18.8	28.5
24	Water evaporated per hr.	22,526	26,700	25,573	30,418	24,085	18478	22,792	14,617	28,577	38,359	14,593	21,721
25	Equivalent evaporation per hr. from and at 212°	24,679	29,698	28,448	33,961	27,050	20,590	25,354	16,083	31,817	43,414	16,002	24,000
26	Equivalent evaporation per hr. from and at 212° per sq. ft. of water heating surface	3.37	4.05	3.88	4.64	3.69	2.81	3.46	2.19	4.35	5.92	2.18	3.28
	CAPACITY.												
27	Evaporation per hr. from and at 212°	24,679	29,698	28,448	33,961	27,050	20,590	25,354	16,083	31,817	43,414	16,002	24,000
28	Boiler Horse power developed	715.3	860.8	824.6	984.4	784.1	596.8	734.9	466.2	922.2	1258.4	463.8	695.6
29	Rated capacity in evaporation from and at 212°	21,155	21,155	21,155	21,155	21,155	21,155	21,155	21,155	21,155	21,155	21.155	21,155
30	Rated Boiler Horse power.	613.2	613.2	613.2	613.2	613.2	613.2	613.2	613.2	613.2	613.2	613.2	613.2
31	Percentage of rated capacity developed.	116.7	140.4	134.5	160.5	127.9	97.3	119.8	76.0	150.4	205.2	75.6	113.4
	ECONOMY RESULTS.												
32	Water fed per lb. of Coal fired.	7.139	6.942	7.201	6.519	7.001	7.215	7.357	7.847	6.910	6.270	7.194	7,022
33	Water evaporated per lb. of Dry Coal.	8.188	7.856	8.128	7.501	8.148	8.375	8.720	9.288	8.000	7.443	8.540	8,375
34	Equivalent evaporation per lb. of Dry Coal.	8.971	8.738	9.042	8.375	9.151	9.332	9.701	10.219	8.907	8.424	9,365	9,254
35	Equivalent evaporation per lb. of combustible burned.	12.195	11.822	12.194	10.971	12.115	12.020	12.456	13.016	11.698	10.434	11.924	11.711
	EFFICIENCY												
36	Colorific value of 1 lb. of Dry Coal.	11,325	11,318	11,211	11,290	11,048	11,282	11,335	11,488	11,303	11,844	11,598	11,094
37	Colorific value of 1 lb. of Combustible.	14,454	14,399	14,325	14,032	14,123	14,175	14,088	14,227	14,209	14,296	14,331	13,773
38	Efficiency of Boiler Furnace and grate.	78.87	74.92	78.27	71.98	80.38	80.27	83.05	96.32	76.47	89.02	78.36	80.95
39	Efficiency of Boiler and Furnace.												

FIG. 5. DATA AND RESULTS OF EVAPORATIVE TESTS 1 TO 12

were made by both National Tube Co. and Robert W. Hunt & Co. from the samples obtained from the aggregate of the 8-hr. samples in tests numbers 5 (24 hr.) and 12 (72 hr.), and directly from the 8-hr. samples and the 1 4-hr. sample in tests numbers 1, 2, 3, 4, 6, 7, 8, 9, and 11 (8 hr.) and 10 (4 hr.). In all cases except in test number 12, the analysis furnished by Robert W. Hunt & Co. was used. In test number 12 it was found that the analysis made by National Tube Co. was sustained by the heat balance and was accordingly used. (In test number 12 the calorific value of 1 lb. of dry coal was found by National Tube Co. to be 11,094 B.t.u., and by Robert W. Hunt & Co. 11,026 B.t.u.) Ash analyses were made by National Tube Co. on samples from all tests obtained by the same method described above for obtaining coal samples, with checks by Robert W. Hunt & Co. on several tests. Care was taken in securing these samples of ash to secure as nearly as possible the same proportions of fine ash and clinker as contained in the ashes dumped.

on the higher evaporations pop-offs were unavoidable, these being carefully timed and accounted for.

Flue gases were drawn from the bottom of the fourth pass and analyzed by an Orsat apparatus. Check analyses were made occasionally with a second Orsat. Gas analyses were made every 15 min., as were all temperature and pressure readings, and the condition of the fire maintained in accordance with the gas analyses. Since each boiler unit has its own stack it was further

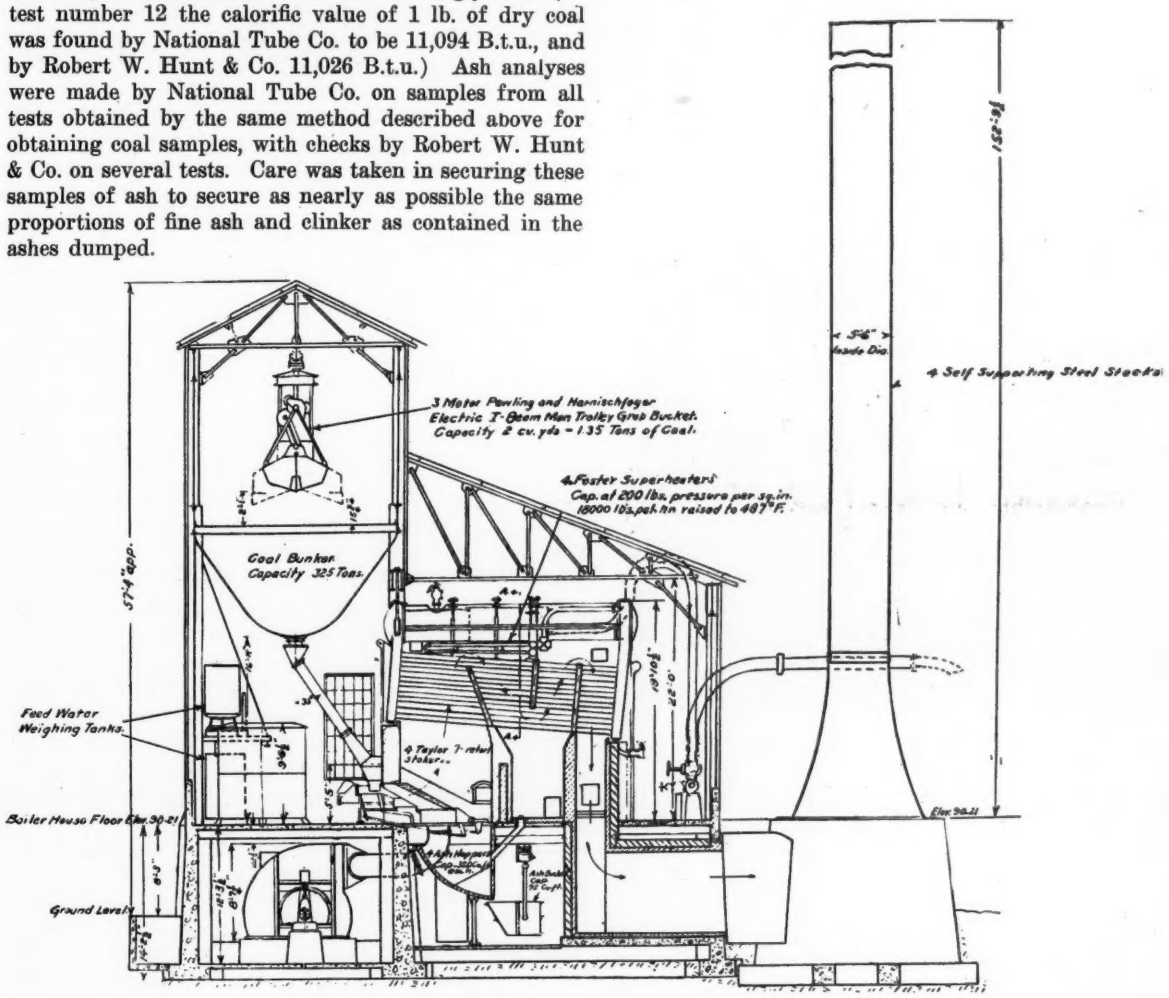

3 Motor Pawling and Harnischfeger Electric I-Beam Man Trolley Grab Bucket. Capacity 2 cu. yds = 1.35 Tons of Coal.
4 Foster Superheaters Cap. at 200 lbs. pressure per sq. in. 16000 lbs. per hr. raised to 487° F.
Coal Bunker Capacity 325 Tons.
Feed Water Weighing Tanks.
Boiler House Floor Elev. 30.21
Ground Level
4 Self Supporting Steel Stacks

FIG. 8. SECTIONAL ELEVATION THROUGH BOILER HOUSE

Temperatures, excepting those of flue gases, were taken with thermometers, which were compared with a standard thermometer. Flue gas temperatures were taken with duplicate thermo-couple pyrometers placed at the bottom of the last pass. Previous to tests these pyrometers were compared with a standard thermometer throughout the working range, and during the tests the average difference in the readings for the 2 instruments was about 6 deg. F.

Gland leakage on the test feed pump was weighed and accounted for. No blow-downs were made during any tests. Safety valves on the test boiler were set several pounds above those on the remaining boiler units, but

possible to regulate properly the air supply to the stoker by observing the smoke condition. As shown by the data, the furnace draft was maintained as low as possible.

Referring now to the first 11 tests, made earlier in the year, the apparent disparity between efficiencies at similar loads is noticeable, and to draw in an average curve through the efficiency points plotted against load would be impossible without additional information. It will be noticed that there is a considerable range in the moisture content of the coal samples, this being due largely to the fact that there was some rainfall after the first 3 tests and much of the coal burned was exposed to this rainfall. It will also be observed that neither

the quality of the flue gases nor the percentage of combustible in the ash forms any definite curve when plotted against the load.

The heat balance as shown gives very little information other than that the tests were too short to be reliable if taken individually. It was therefore deemed practical and profitable to create a second heat balance based upon the average of such factors as were not influenced by the rate of firing, such as moisture, CO in flue gas, and combustible in the ash; and to change the dry flue gas loss to correspond to gas temperatures obtained from curve (B), Fig. 3; and to balance the whole with the radiation loss which is obtained from (A), Fig. 3. This relation is assumed after careful comparison of the Kewanee boiler settings with those of the large units in the Detroit-Edison plant, where such a splendid set of tests have been conducted, to give reliable radiation and miscellaneous losses. The setting comparisons were made

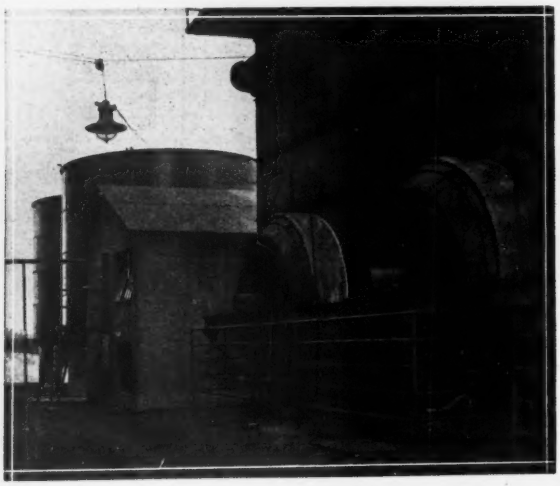


FIG. 9. COOLING TOWERS AND WATER PURIFYING PLANT

upon a basis of exposed areas, temperature of exposed areas above boiler room, and character of setting wall, together with the relative rated capacities of units.

Information obtained from other tests has been considered as throwing some light on the subject. With the efficiencies thus created a second set of points has been laid out on the load-efficiency plot and through them a curve drawn. If the assumed radiation loss is too great or too small, the created efficiency will be lowered or raised accordingly; but if the general slope of this radiation curve is maintained, the relative position of the created efficiency points will remain unchanged, the curve will merely fall or rise. In effect it is thought that this created curve represents approximately what would be accomplished by tests of indefinite length, with coal of the average moisture, hydrogen, etc., as obtained during these tests, and with the same combustion as shown by the average of the gas and ash analyses for these tests. It is assumed, too, that the condition of the water heating surface shall remain the same.

Bearing the above in mind, referring to the actual heat balance for test number 12, a 72-hr. test, it will be observed that the residue for radiation and miscellaneous losses falls upon curve (A) in Fig. 3. Also, that if the same method of creating a heat balance is pursued in test number 12 as in tests 1 to 11, inclusive, the efficiency as obtained falls very close to curve (A) in Fig. 3.

In explanation of the high efficiencies obtained in the entire 12 tests, in addition to the heat balance, the following will be instructive:

Losses as shown in the table of computations of results are due to, (95) moisture in coal, (96) hydrogen in coal, (97) dry flue gas, (98) carbon monoxide, (99) carbon in the ash, (100 and 101) radiation. Critical factors in determining the amounts of these losses are: 1. For 95, 96 and 97, outlet temperature of the flue gases which requires for good efficiency good heat absorption by the boiler. This is secured by clean heating surfaces both inside and out, and in particular at Kewanee by the use of soot blowers and a water-purifying plant; also by long gas passage in contact with heating surface, secured at Kewanee by a 4-pass setting and superheater, and low temperature of the saturated steam in the boiler, secured at Kewanee by running at low pressure. 2. For (95) another factor in loss is the amount of moisture and for (96) the amount of hydrogen in the coal, both being independent of the installation, therefore not controllable by design or operation of the plant. 3. Dry flue gas loss (97) depends also on the quantity of such gases, and to keep this small, there must be good combustion and minimum leakage of air through setting and around the grate. The latter is secured by a tight setting and close fitting and at Kewanee, by brickwork painted, covered with magnesia and muslin and again painted. Good combustion depends on high temperature secured by a large combustion chamber; proper coal supply to fuel bed; minimum of air properly distributed through grate, and proper segregation of ash from combustible remaining on the grate, secured by use of the Taylor stoker; and minimum of draft through the setting, secured by using a forced-draft system. 4. Loss due to CO, (98) depends on the amount of CO in the gases, which in turn depends on good combustion already discussed; also, on the difference in heating value between burning to CO_2 and to CO, this difference being independent of the installation. Carbon in the ash also depends on good combustion which is mentioned above, and the other factor of (99), heating value of combustible, is independent of the installation. 5. Radiation loss (100 and 101) has as its governing factors the area of exposed surfaces and their temperature. The former is reduced by keeping the exposed surface small in comparison with water-heating surface, by using large units; and at the latter, by making the setting walls and coverings of good heat insulating material, using thick brickwork and covering all radiating surfaces with magnesia compound.

In general, it will be observed that while the analysis of the fuel used in all these tests would not lead to the expectation of high efficiencies, all other factors involved were of a favorable tendency.

All tests were conducted by National Tube Co., Kewanee Works, engineers, under the personal direction of the writer, who is also responsible in the main for the design of this installation. In all of the tests capable assistance was given by W. I. Bowden, Foreman of Erection of the American Engineering Co. In the final 72-

hr. test, Professor G. A. Goodenough, of the University of Illinois, kindly lent his presence and supervision. There were also present during the entire 3 days the following: A. P. Kratz, First Assistant in Engineering Station, University of Illinois; A. L. Menzin and R. H. Kuss, representing the Edge Moor Iron Co.; Roy L. Younglove, Assistant to Mechanical Engineer, Illinois Steel Co.; F. L. Pinkham, A. Steinbart and Alex. Hoerr, Pittsburgh, Pa., constituting the Steam Committee of National Tube Co.

In the discussion of this paper, exception was taken to the use of the corrected values for efficiencies, and particularly with regard to the method of obtaining the heat balance, in which the radiation loss was taken from curve (A), Fig. 3. It was claimed that this curve, which was established by the Detroit-Edison tests, is not applicable here on account of the relative sizes of the combustion chambers of the boilers used in the tests at Kewanee and Detroit, that of the latter being several times the former. The unaccounted for losses would increase rather than decrease with the load, unless the combustion chamber were of sufficient size to handle the large volume of gases necessary for operation at high rating.

It was asked why the heating value per pound of combustible was so much lower in test No. 12 than in any of the previous tests, and was stated that the efficiency reached in test No. 12 was 91 per cent of that possible with an ideal furnace and stoker.

In the next discussion a point was raised as to the quantity of steam used to drive the stoker and fan engine and also that consumed by soot blowers. From the standpoint of overall economy these things should properly be considered by the purchaser of steam geenrating equipment.

It was claimed that in previous tests boilers equipped with other stokers carried a greater overload just as economically as in the Kewanee tests and for a longer period than in this case. The question was asked why the test at maximum rating lasted only 4 hr.; whether the short period was due to difficulties encountered in handling the large amount of ash and refuse present in the low grade of coal used?

Speaking from a commercial point of view, the manager of the Kewanee plant of the National Tube Co. stated that in actual operation no excessive peak loads have to be met, although there are slight peaks in the morning and evening of each day. The maximum load is handled by 3 of the 4 boilers operated at not to exceed 150 per cent rating. A careful check is made upon the quantity of feed water evaporated by the use of a 3-in. Venturi meter that can be connected to any 1 boiler and a 6-in. Venturi meter that measures the total quantity of water fed to all the boilers. The water is also measured in purifying tanks of known capacity.

Coal is weighed and the weight checked from the revolutions of the stokers obtained from counters. During the months of October, November and December of 1913, the average heating value of the coal as fired was 9500 B.t.u. per pound, and the monthly efficiency of the installation was between 77 and 78.5 per cent. The primary object in the selection of the equipment was to effect a maximum saving in fuel, and the result has been a saving of from $30,000 to $40,000 a year.

In his final remarks the author of the paper replied to the questions asked and offered explanations on points not made clear in the original paper, as follows:

Just why the coal in test No. 12 showed a heating value so much lower than that of the others was not known. Part of the coal used in this test had, however, been stored for some 6 months previous in the bunkers over an unused boiler and might have been affected by spontaneous combustion. Again, it may have been a little poorer in quality as mined.

While it was not known exactly how much steam was used by the stoker and fan engine, the quantity was very small in proportion to the amount generated by the boiler. The soot blowers are imbedded in the baffling

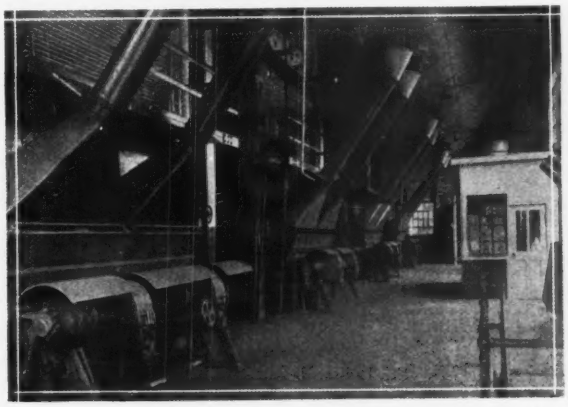


FIG. 10. BOILER ROOM VIEW

and steam for this purpose was admitted through a 3-in. valve, but the valve was opened and closed about as quickly as possible each time. This blower was used twice daily, at 6:30 a. m. and 6:30 p. m.

Popping of safety valves was timed in each case and the quantity of escaping steam calculated on the basis of saturation. Grates were dumped every 2 hr.

The most economical combustion was found to take place with just enough air to produce a slight haze at the stack, and this condition was, so far as possible, maintained throughout each test, as at this point the flue gas analysis showed a maximum of CO_2, no CO, and a constant percentage of O. When less air was admitted, combustion was incomplete, as shown by the smoke from the stack, a smaller percentage of CO_2, some CO, and less O. With slightly more air than that required to produce the haze, there was no smoke, but the analysis showed less CO_2, no CO, and more O. As the amount of air was further increased smoke began to appear, with still less CO_2, some CO, and, of course, more O.

As the manufacturer's contract specified a guarantee at a rating of 200 per cent, there was no object in operating with a greater load than 205 per cent rating, which was carried in test No. 10. The reason given for terminating this test at the end of 4 hr. was because of the stoker and fan engine, which developed a "knock" that gradually grew worse. The engine was running at about 450 r.p.m. and it was not deemed safe to continue in this condition at the end of the fourth hour. The author of the paper stated that this test could easily have been carried on with the same coal for 8 hr. or a longer period, except for the engine trouble.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Planning Lighting Installations*

REQUIREMENTS FOR VARIOUS CLASSES OF BUILDINGS, PROPER INTENSITIES SPACINGS AND USES OF DIFFERENT TYPES OF FIXTURES. BY J. B. JACKSON

ILLUMINATION is a subject which has commanded a great deal of attention within the past 2 decades. Within this time the art has made rapid strides, due to the great development in different illuminants, and the efforts of those who have been engaged in research, either from a physical, psychological or engineering standpoint.

It has not been uncommon in the past that provisions have been made for a certain number of outlets for an interior and the actual design of lighting equipment left until the building is practically completed. Very little consideration has been given in a great many instances to the factors which influence illumination results. This imposes conditions which are later hard to meet, and the design usually becomes a matter of compromise. To obtain definite predetermined results it is necessary to know in advance the general schemes of decoration and the type of lighting equipment desired and provision must be made for its correct use.

Methods of planning lighting installations have scarcely kept abreast of the recent developments. The high power gas and the tungsten incandescent unit require somewhat different treatment than did the open flame burner and the carbon incandescent unit. Since these latter sources have a high intrinsic brilliancy it is essential that they be removed as much as possible from the field of vision if we are to afford any protection to the human eye.

BASIS FOR CALCULATIONS

WITH THE information now available it is possible to apply engineering principles to the design of lighting installations and obtain results which are more satisfactory in every respect. It is essential in considerations of light sources to have a clear conception of light as a quantity. Every lighting unit is capable of being evaluated in terms of a standard. It is unfortunate that the term candle-power has received such wide application. This would not be such a serious condition were it not for the fact that every unit has been referred to in terms of its maximum candle-power and has as a consequence given rise to some erroneous conclusions.

Were we to consider a light source suspended in the center of a sphere in such a manner that all the light is intercepted by the interior surface, and we make use of some method of either measuring or calculating the light enclosed within the sphere, we will then have a direct means of comparison of one light source with another. It is evident then, that if light sources are expressed in terms of their average candle-power (otherwise called mean spherical candle-power), we may then make comparisons, since the last quantity always bears a definite relation to the total flux of light. A standard unit of luminous flux has been chosen which is designated the lumen which, for the purpose of this paper, need only be defined as a measurable quantity of light, equal to 12.57 times the mean spherical candle-power.

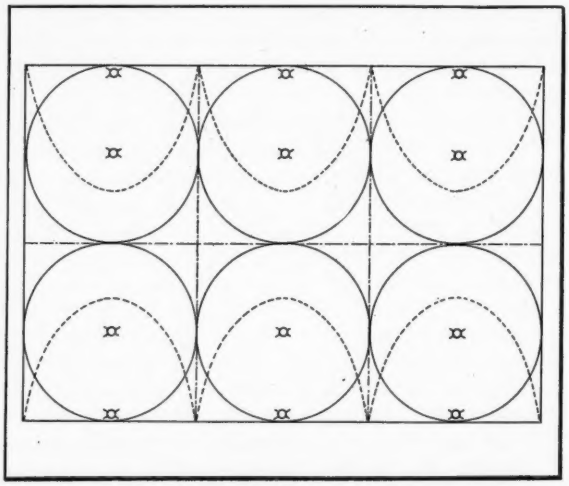


FIG. 1. COMPARISON OF CEILING AND BRACKET FIXTURES FOR GENERAL ILLUMINATION

Table 1, given in the Practical Reference Tables, is an evaluation of the different kinds of incandescent electric lamps which have been used or are in use at the present time. The first column gives the common designation as to kind of filament or some common characteristic which has been associated with the lamp. The second gives the nominal candle-power (in case of the incandescent units being the horizontal direction). The tungsten or mazda units have usually been expressed in terms of watts consumed, hence their horizontal candle-power values are not so commonly known. The third

*From a paper read before a joint meeting of Illuminating Society, Chicago Section, and the Chicago Architects' Business Association.

gives the energy consumption expressed in watts. The fourth column contains the value of the lamps in terms of light units (lumens), as referred to above, and may be taken as a measure of the illuminating value. In the last column is tabulated a multiplying factor to be used in connection with a later table, as will be explained. In the consideration of this table it should be remembered that these values apply to the quantity of light given off by the lamp unequipped with reflector, globe or other accessory.

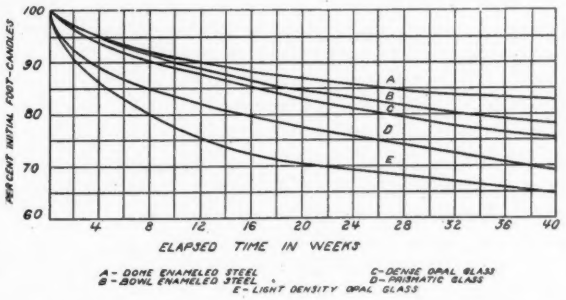


FIG. 2. EFFECT ON ILLUMINATION INTENSITY OF COLLECTION OF DUST ON LAMPS AND REFLECTORS

The next question which naturally arises, is how are we to determine the amount of light on any surface, also how are we to obtain a measure of the light required for certain classes of service? If we can imagine that light is radiated from a source in the form of rays which, for purposes of illustration, may be considered as analogous to fine wires, and let some surface intercept a portion of these rays, it is evident that the number of rays which fall on a unit area represents a measure of the flux density or the density of the light rays upon the surface. If a standard be chosen which will represent a certain flux density, then it is possible to measure by means of photometric apparatus any flux value in the terms of this standard. This standard has been given the name foot-candle, and should be considered as being independent of the source of light and the distance from the source as being only a measure of the density or intensity of the illumination produced.

Suppose an observer place himself in a position before a desk with a printed sheet of standard size type and we vary the illumination upon this sheet, and when the illumination has reached a value which satisfies the observer, a measurement is taken. By taking a series of these readings and obtaining an average value, it is possible to state that for that observer the intensity value obtained may be considered as satisfactory for that class of service. These values vary in different observers, as one authority (Cravath) has stated, as much as 5 to 1.

Table II gives the value in foot-candles for different classes of services, these have been obtained by pursuing methods which are similar to the one described above, that is, an average value has been obtained in some installation which has been classed as satisfactory. Relative to intensities required, there seems to be considerable tendency to require more and more light. In other words our standards are rising gradually, probably not due to any change in the human eye, but more likely because ample illumination is more easily and cheaply available. It will be noted that the values given in the table are in ranges, such as 2 to 4 foot-candles, being given in this manner to allow some opportunity for the designer to make a choice according to his knowledge of the service required. Values given in the table are averages for the entire room.

Fixtures

There are 2 classifications of fixtures in general use at the present time, namely, ceiling and bracket. Of these an inspection of Fig. 1 will show that a ceiling fixture is much more efficient as a lighting unit. With the spacing of ceiling outlets placed in the center of approximate squares we approach the nearest to the condition of uniform illumination which, for some purposes, is considered to be ideal. The use of bracket fixtures for general illumination is not to be recommended and should be used only when some consideration is given to special or decorative features. In commercial work, it is safe to state that bracket fixtures have very limited application. Fixtures of this type have often been in-

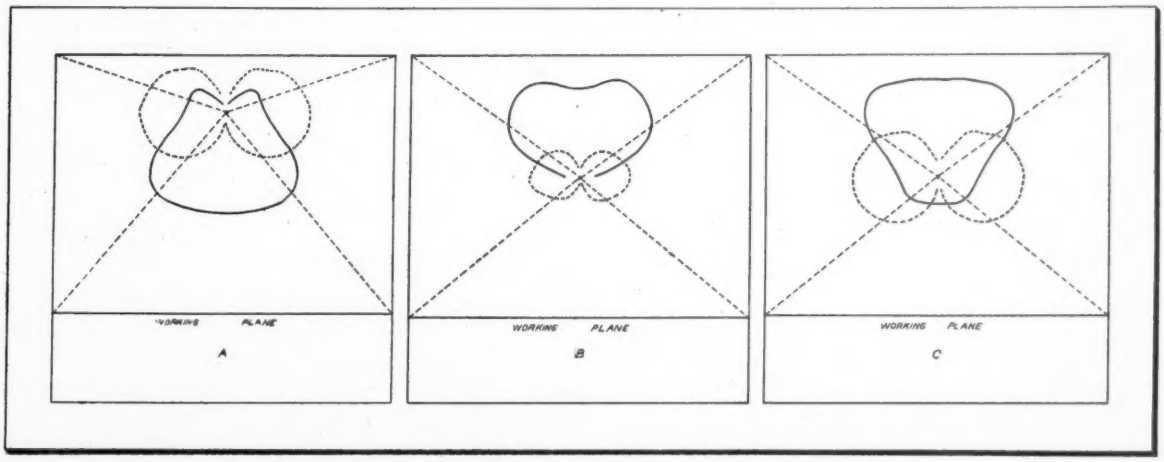


FIG. 3. LIGHT DISTRIBUTION BY DIFFERENT SYSTEMS OF LIGHTING

stalled and the reason advanced for doing so, that they can be used for connection for fans, portable lamps, etc. This is not to be encouraged, as baseboard and floor receptacles make a much more convenient and sightly connection and, as a general rule, at a cheaper installation cost. If sufficient capacity were installed for bracket fixtures for general illumination, the center of the room would be darker than near the walls. Under these conditions objectionable glare almost always is introduced, as the usual bracket is much too low for use under these conditions.

As stated above, the most even distribution of light is obtained by the use of ceiling units spaced in the center of squares or rectangles approaching squares. The size of these squares is determined by the architectural features of the building, such as dimensions of bays and ceiling height. Table III, given in the Practical Reference Tables, shows desirable sizes of squares for location of ceiling outlets under different ceiling heights and for different classes of buildings.

Effects of Dust Accumulation

Collection of dust and dirt affects different reflectors in varying degrees, as is shown by Fig. 2, which is presented by the courtesy of the National Lamp Works, the curves being the results of tests made in Cleveland. The vertical scale represents per cent of the initial illumination value, and the horizontal scale the time elapsed in weeks. Curve A represents the results obtained from a dome-shaped, enameled steel reflector; curve B, a bowl-shaped reflector of the same material; curve C, a heavy density opal glass; curve D, prismatic glass; curve E, light density opal. In referring to opal glass in terms of its density it must be remembered that the term density refers to optical, not physical, density, and is also independent of the thickness of the glass. The lighter density the opal, the higher is the light transmission value. The prismatic glass used in the test was the type which is familiar to all, consisting of a reflector of clear glass with carefully designed prisms on the exterior surface.

Contrary to the general belief, these tests show that prismatic glassware is not affected by dirt to as great a degree as is the light density opal. Under this latter classification will come the most of the opal glass which is being used commercially. These tests did not include any figures on indirect lighting, but it has been stated, as a result of tests made at Armour & Co. offices at Union Stock Yards, Chicago, that the figure of 10 per cent a month holds for at least the first 2 months, when mirror reflectors are used. As this last figure corresponds fairly well with results on the curve, it would indicate that the position of the reflector has not as great bearing as has been supposed.

If we would set 15 per cent as the allowable depreciation on lamps and reflectors, the cleaning period would be 6 weeks for indirect, prismatic, light and medium density opals; and 16 weeks for steel and heavy density opals.

Much can be accomplished by impressing upon the proprietor the necessity of regular cleaning periods. It is not uncommon that installations have been known to be allowed to go without cleaning for a period of more than a year. This installation might give only 25 to 50 per cent of its initial value, as the equipment used was light density opal which is affected the most of any of the reflector types shown.

Systems of Lighting

In referring to systems of lighting, 3 terms have come into general use—direct, semi-direct and indirect. The lines of demarcation between these classes are rather hard to draw, but present definitions are about as follows: The term, direct lighting, is applied to systems in which a large part and, in some cases, all of the illumination on the working plane is received directly from the lighting units (lamps and their equipment); indirect when no light is received directly, but is obtained by reflection from ceilings and walls; semi-direct when only a part is received directly, the greater percentage being obtained indirectly.

Figure 3 illustrates the 3 different systems, the curves representing the distribution of light about the unit, the curve of the bare lamp being shown dotted in each case as a method of comparison.

Inspection of the figures show that the light which we obtain on the working plane is composed of 3 parts, the light received directly from the unit, plus a portion of that directed toward the walls, plus a portion of that

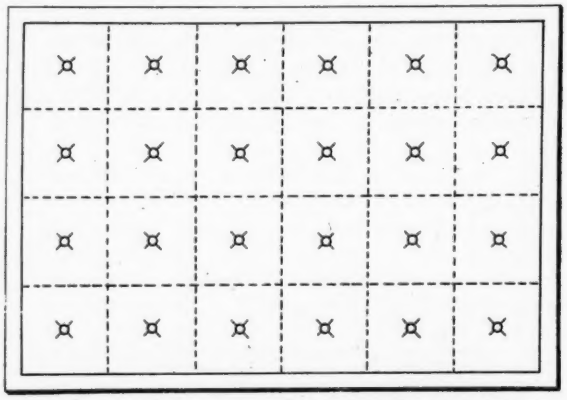


FIG. 4. LOCATION OF OUTLETS IN LIGHTING PROBLEM

directed toward the ceiling. It is evident therefore that color of walls and ceilings very materially affect the total illumination, as color is an indication of the absorption of light, i.e., the darker the color sensation the higher the absorption value; the exception to the above rule being units which direct practically all of the light toward the working plane.

In planning a lighting installation it is essential to consider all the quantities which affect the illumination results, namely, architectural features, intensity required, kind of lamp (such as tungsten incandescent), type of accessory equipment, decorations, etc. In order to simplify matters as much as possible a table has been made up containing all these variables, excepting the intensity required for the service. In doing this it has been necessary to assume a lamp for general use for this purpose, the 100-watt tungsten lamp of the January, 1914, rating has been selected. In making calculations, average lamp depreciation of 3.6 per cent has been allowed for. The large sizes of lamps, however, will give somewhat higher results, while the smaller sizes will give lower, so for the exact values of lamps other than the

January, 1914, 100-watt tungsten, multiply results in the table by the quantity under multiplying factor in the table of Lamp Values, Table I.

Below Table IV are given 3 colors under each of the classifications, Light, Medium and Dark; these are given as a guide for classifying the different conditions of ceiling and walls. Figures are given in 3 places, although no significance should be attached to the last place.

As an example of the method of calculations, assume the following conditions; illustrated by Fig. 4:

Width of space.....40 ft.
Length of space.....60 ft.
Ceiling height .....11 ft.
Ceiling color .....Light
Wall color .....Medium
Service requirements — general office illumination without desk lamps.
Type of the equipment—medium density opal.
Area—40 by 60.....2400 sq. ft.

From Table III—10-ft. space of units is the best adapted for the given ceiling height and dimensions of the space considered.

From Table IV—Constant for medium density opal with light ceiling and medium walls—0.235 watts per square foot required to produce 1 foot-candle illumination.

From Table II—Intensity required for office purposes under the conditions named, is 4.0 foot-candles.

Number of units—24.

Area per unit—100 sq. ft.

Intensity value $\times$ constant = watts per square foot.

$4 \times 0.235 = 0.94$ watts per square foot.

Depreciation—15 per cent.

$0.94 \times 1.15 = 1.08$ watts per square foot to be provided.

$1.08 \times 100 = 108$ watts per outlet.

As an example of the use of other types of incandescent units, if it were desirable to use candelabra carbon lamps, reference to Table I shows that the 100-watt value obtained when using tungsten lamps must be multiplied by a constant tabulated in the last column, namely, 3.10 from which it is evident that to obtain the same illumination results it is necessary to use 310 watts in the lamps designated.

Relative to the final design of lighting fixtures, the manufacturers of equipment have available comprehensive publications showing in detail, sizes, shapes and designs of all their products. These will be found of great value in making distinctive designs and no difficulty should be experienced in producing in fixtures, effects to conform with any architectural treatment which is considered advisable.

The steps to be taken in planning a lighting installation would be as follows:

1. Determination in a general sense the type of the lighting to be used, including decoration and kind of unit.
2. Spacing of outlets from architectural considerations.
3. Intensity required.
4. Calculation of capacity of outlets from Tables II and IV.
5. Necessary wiring installation.
6. Final selection of fixtures with reference to mounting height, selection of accessories (glassware, etc.) and general design to conform with architectural treatment of buildings.

It is to be remembered that the plan of procedure indicated in this paper is not given as hard and fast rules, but rather as a suggestive method to be used as a basis of design; also, that the mere fact of obtaining a certain intensity value on the working plane does not constitute all the necessary considerations in planning.

One system may be suitable for some certain class of service which would be very much out of place in another.

Maintenance of Electrical Apparatus

I SHOULD like to know the most essential points for the proper maintenance and operation of step-down transformers, oil switches, induction motors and current measuring instruments, and how to read the latter.

J. H. A.

A. In operating transformers of moderate voltage, care should be taken that the oil in the transformer does not fall below a safe point, as shown on the oil glass. If there is no glass, a safe rule is to have the core and coils covered with oil to a depth of at least one inch. All observations as to depth of oil should be made when the transformer is warm on account of expansion of the oil with heat. Care should be taken to keep all dirt and moisture out of the transformer, and any oil put in should be clean and dry. Transformer oil can be obtained from any manufacturer of transformers. The temperature of a transformer should not be more than 50 deg. C. above the temperature of the room.

Oil switches should be kept filled with oil to the level marked in the case. All contact surfaces should be kept smooth and true. It is good practice to trip the switch at convenient intervals by means of the overload device.

Induction motors should be kept free from dirt by occasional blowing out with compressed air or a hand bellows. Do not allow oil to accumulate on the insulation, as it will gradually injure it. Keep bearings filled with good oil. See that the air gap, that is, the space between the rotating and the stationary points, is the same at top and bottom. The maker of the motor will usually furnish a gage for testing this air gap, if requested at time of purchase.

Current measuring instruments should not be opened by any one unfamiliar with the construction and operation of such apparatus as the mechanism is delicate and easily injured. They should be mounted where they are free from vibration, and any resistance or transformers outside the meter case be kept free from dust. Do not change the length or location of any wires without first making sure that it will do no harm. Never open the secondary of a current measuring instrument transformer when current is flowing in the primary. It may be dangerous to life.

Current measuring instruments usually read direct: that is, the scale is calibrated so that the pointer indicates the current in the main wire, but not always the current in the instrument itself.

Foreign Development In The Power Plant Field

PREVENTION OF CORROSION AND SCALE FORMATION, CORROSION OF CONDENSER TUBES. BY J. H. BLAKEY

THE Cumberland process for the prevention of corrosion and scale formation, which has been brought out recently in England, is as follows: Anodes of iron, which are carefully insulated, are immersed in the water of the vessel to be protected, which may be a boiler or a condenser, and a measured and regular amount of electrical current supplied to each. The current is direct, low tension (6 to 10 volts) and controlled by separate resistance coils for each anode. The vessel itself is connected to the negative pole of the source of electricity, the production of hydrogen in the vessel being thus controlled by the amount of current supplied. The current passes from the positive pole of the generator to the anode, through the water, a small part of which is decomposed, and enters the metal of the vessel and thence returning to the negative pole, liberates hydrogen on the surface of the boiler or condenser tubes.

The action of the current is thus to attract the oxygen and acids contained in the water to the anodes where they combine with the iron and form oxide of iron, which is harmless and falls to the bottom of the vessel as a fine dust. The hydrogen is thus left to form on the vessel and prevents the accumulation of any scale or solids. It is also claimed that the process promotes the solution of grease or scale previously formed. As compared with the use of zinc plates, which are sometimes used for the same purpose, one ampere of current supplied to an electrode is equal to 250 sq. ft. of clean zinc, reckoning the current generated by 1 sq. ft. of zinc at 0.004 amp. With the Cumberland process the effect remains constant, whereas in the case of the zinc the beneficial effect decreases until the polarity is reversed.

CORROSION OF CONDENSER TUBES

THE SECOND report of a committee of the Institute of Metals appointed to study the corrosion of condenser tubes was read at the Ghent (Belgium) meeting on Aug. 28. Information obtained by enquiry among users of condensers brought out the following facts: 1. The erratic nature of the trouble. Different users gave as the normal life of the tube, periods varying from 4 to 25 yr. 2. The nature of the deterioration is in a great majority of cases dezincification, which results finally in a pitted and rotten tube. This type of corrosion is called "selective corrosion." Occasionally tubes fail by localized complete corrosion, that is, by the removal of both copper and zinc over certain areas. 3. It is not possible to connect the failure of tubes with the presence or nature of the electric lighting system, as might be supposed if the corrosion were the result of electrolytic action. 4. There is no obvious connection between any definite locality in a condenser and the frequency or extent of dezincification.

Laboratory tests were conducted on tubes composed of the following alloys: 1. Brass, containing 70 per cent copper and 30 per cent zinc. 2. Special brass, 70 per cent copper, 28 per cent zinc and 2 per cent lead. 3. Muntz metal, 61 per cent copper and 39 per cent zinc. 4. Admiralty metal, 72 per cent copper, 27 per cent zinc and 2 per cent tin. Experiments with these tubes at a temperature of 20 deg. C. (68 deg. F.) gave the following results: 1. Corrosion at this temperature is always of the approximately complete kind and is slow and uniform. 2. The presence of carbon (in the form of coal, graphite or coke), sand, copper and a number of other bodies, have of themselves little or no effect on the type of rapidity of corrosion. They do not give rise to any appreciable electro-chemical action. Certain basic salts of zinc and iron appear to have some effect, but too small to be of importance. 4. In the case of marine condensers, an increase in the concentration of sea water increases the speed of corrosion, but the type is unaffected. 5. The order in which the tubes resisted loss of weight, was as follows: a. Muntz metal (lost least weight). b. Special brass (containing 2 per cent lead). c. 70 per cent—30 per cent brass. d. Admiralty metal. 6. An increase of the speed of the flow of water in the condenser increases corrosion. 7. Selective corrosion could not be obtained at 20 deg. C., except by the employment of free acid. 8. No evidence is given that flaws in the metal have any effect on corrosion at this temperature.

Experiments at 40 deg. C. (140 deg. F.) gave results as follows: Corrosion at this temperature is of a distinctly selective type, that is, zinc is removed from the metal in greater proportion than copper. 2. This action is not uniform, but begins at certain points and spreads outwards. The causes which determine the distribution of these points are discussed in detail in the report. 3. The order of resistance to corrosion at this temperature is: a. Special brass. b. Admiralty metal. c. Brass. d. Muntz metal. 4. The presence in the water of zinc oxychloride gives rise to severe dezincification.

Enquiries having elicited the fact that it is quite probable that temperatures of 50 deg. C. and upwards are often obtained in condensers, especially where superheated steam is used, experiments were also made at this temperature (122 deg. F.), and gave the following results: 1. Corrosion at this temperature is of the selective type and is concentrated almost entirely on the zinc. Traces only of copper were removed from the tubes. 2. The action is severely localized. 3. The order of resistance is: a. Admiralty metal (most resistant). b. Muntz metal. c. 70-30 brass. The last 2 named showed signs of dezincification in 7 days, but no signs of this action could be detected in the Admiralty metal in 4 weeks. 4. The total weight of metal lost at 50 deg. C. is lower than at lower temperatures for equal lengths of time. 5. If the water is aerated the weight lost is enormously increased, and is greater than at lower temperatures. 6. The effects of particles contained in the condenser water is the same as at other temperatures.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Commutator Repair

ACCOMPANYING SKETCHES represent a quick repair job on a 7½-kw., 110-volt, 220-r.p.m., d.c. generator which we recently disposed of on account of its unreliability. Figure 1 is an end view of the commutator showing where short circuit occurred between bars 1 and 2. This was a common occurrence and the machine was in the shop nearly as much of the time as it was running. One day it blew as usual, so I took a hack saw

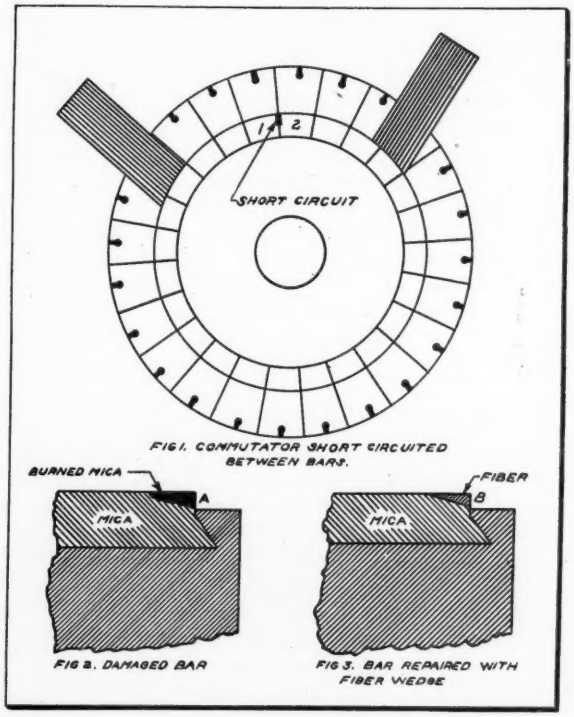


FIG. 1. END VIEW OF COMMUTATOR SHOWING LOCATION OF SHORT CIRCUIT

FIGS. 2 AND 3. DAMAGED BAR AND METHOD OF REPAIR

blade and sawed out the burned mica, Fig. 2-A, cleaned it out thoroughly, made a wedge of red fiber, covered it with white shellac and drove it in between the bars, trimmed it off smooth and started up. This would last from 3 weeks to a month, when the fiber would become carbonized and short again. The armature of this machine was drum wound, double layer, single lap, pitch 14, and 61 commutator bars.

The generator was a 4-pole machine compound wound, and had 2 brushes spaced the same as the winding pitch.

The short between the bars always occurred in the same place and several times when I was away working in some other part of the plant, it burned out the coils connected to the bars between which the short occurred.

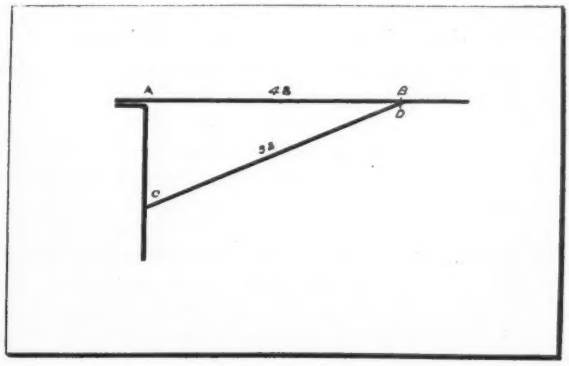
I contended that the winding pitch was wrong and was what caused the short and should like to hear the opinion of someone else on this.

The machine has since been replaced by a 12-kw. machine, which carries the same load 24 hr. a day, and has not been shut down for over 3 months; it is belt driven from a 10-hp., 220-volt, 3-phase, 60-cycle, 1200-r.p.m. induction motor, and furnishes light for the places needed during the day at about ½ the cost of city light, as light rates are about twice as much as power rates.

ASSISTANT.

Staying the Boiler Head

IN STAYING the head of a 72-in. boiler, the first thing we must do is to find the area of the segment to be braced. It was found by experiment that the shell supports the head for a distance of 3 in. and the tubes 2 in. Therefore, the diameter of the circle of which the segment is a part is $72 - 6 = 66$.



LOCATION OF STAY IN BOILER

From the bottom of the boiler to the top of the tubes is 60 per cent of the 72 in., or 43 in., and the distance from the top of the tubes to the top of the shell is $72 - 43 = 29$ in., subtracting 3 in. from the top of the shell, and 2 in. from the top of the tubes, making 5 in. in all, leaving $29 - 5 = 24$ in., the height of the segment.

Dividing the height of the segment by the diameter of the circle, of which the segment is a part, we get $24 \div 66 = 0.363$; the square of the diameter multiplied by the decimal 0.2574, which will be found in the table of areas of segments of circles for this height

of segment, gives $0.2574 \times (66 \times 66) = 1121$ sq. in., as the area of segment to be braced. Assume the pressure is to be 125 lb. per sq. in., then $1121 \times 125 = 140{,}125$ lb., total pressure to be borne by all the stays. Suppose we use a 1-in. stay, the smallest size that is to be used on boilers with a diameter greater than 44 in. The area of each stay will be 0.7854 sq. in. and will resist a stress of $7500 \times 0.7854 = 5890$ lb. Then, to find the number of stays, divide the total pressure on the segment by the stress each stay will resist, and we get the required number of stays.

$140{,}125 \div 5890 = 24$ stays. The strain on any stay making an angle with the shell is greater than the strain on a direct stay. If the distance A B is 48 in. and C D 52 in., the stress will be $52 \div 48 = 1.08$ times greater than on a direct stay; therefore, the 1-in. stays are not large enough, but must be $0.7854 \times 1.08 = 0.85$ sq. in., which corresponds to a diameter of 1 1/16 in.; therefore, this boiler would require 24 1 1/16-in. stays. With this pressure, the number of stays as given above could not be properly distributed over the boiler head, so we must use a smaller number of stays; but the combined area of the smaller number of stays must equal the combined area of the 24 1 1/16-in. stays. The combined area of the 24 1 1/16-in. stays equals $0.85 \times 24 = 20.40$ sq. in. We will use 18 stays, which is the amount used in best practice.

Then, to find the area of the stay, divide the combined area of the 24 stays by 18, which gives us $20.5 \div 18 = 1.14$ sq. in., which corresponds to a diameter of 1 5/32 in.; therefore, a 72-in. boiler would require 18 stays 1 5/32 in. in diameter. M. V. Miller.

Laying Up the Plant

In the Jan. 15 issue, I have just read an article by J. C. Hawkins, on laying up a plant for a season.

I cannot see how the average operating engineer can gain anything by following Mr. Hawkins' advice, at least in repacking all valves and reseating them.

Of course, Mr. Hawkins calls attention to the money end of this; that his company does not care for operating expense. What I am trying to bring out, is this: If I have 2500 valves in my plant, I can safely say that 1250 of them are opened or closed less than once in 60 days. This being the case, then, in one season, say of 8 months, the valves will be moved 4 times. Why should I repack them and spend about $20 for unnecessary packings?

Now, for instance, a young, inexperienced engineer will take charge of a small plant, say where I am, at 335 hp. We have steam heating, using exhaust steam. My total packing for the year 1913 was 21 lb. I figure an average of 75 cents per lb., which equals $15.75. There are about 1000 valves in this plant and not one of them leaks or blows.

This young, inexperienced engineer takes my place and he reads this article of Mr. Hawkins', on repacking all valves. Spring comes, heating system shut down, and he commences ripping packing out of about 900 valves, all the way from a ¼-in. to an 8-in. valve. His packing bill will run up to about $15 or $20 to start with, on the valves alone, and the plant itself will again need about 20 lb. of packing for the next year for engines, steam traps, pumps, etc. So we have about $40 to $50 for packing. The manager may quiz him as to what he is doing with all this packing.

He will say: "Why, I pulled out and repacked 900 valves last month."

The manager will ask: "Were they all leaking or bad?"

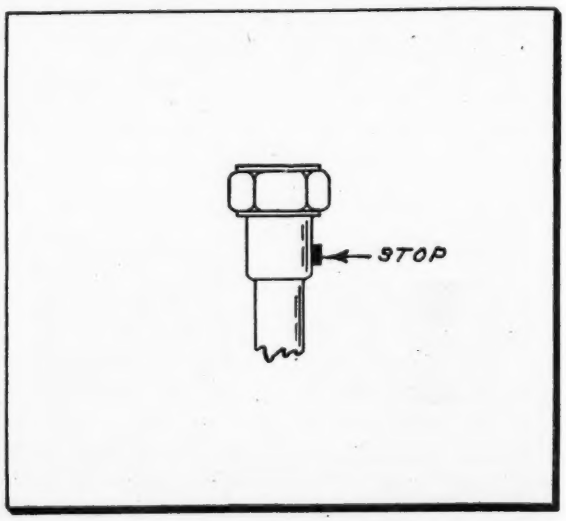
He'll answer: "Oh, no, but that is efficient and modern engineering to repack all valves every summer when the system is laid up."

How long an engineer of this kind will last you may make a guess. W. B. Hauke.

Stop for Coupling Nut

Lubricator and gage pipe coupling nuts are undoubtedly the cause of more burned wrists and damage to good disposition on the part of the engineer than any of the other minor causes of trouble about the plant. In the majority of cases lubricators and gages are so placed that a disconnected nut will invariably drop down over the pipe and into the midst of a great number of other heated pipes and parts, out of which it is often extracted with difficulty.

The sketch is descriptive of a simple kink for keeping the nut from slipping down over the pipe and tailpiece. A few drops of solder form a stop for the nut which will keep it up where it belongs when disconnected, but



DROP OF SOLDER SAVES TIME AND BURNING FINGERS

which at the same time can be quickly removed with a file when it is necessary to renew the nut. At the same time, however, the nut can be screwed back far enough to clear the threads of its connection to the lubricator or gage nipple.

It requires little work to fix the tailpiece at any time it may be necessary to remove the pipe, and when a defect occurs in the lubricator or gage necessitating the uncoupling of the nut, the "kink" will be found a safe precaution against injury and loss of time.

F. W. Bentley, Jr.

Knock In Engine

In the Jan. 15 issue, G. L. K. asks for some solution to the knock of his engine. My opinion is that the valve setting is at fault.

Indicator diagrams should be taken when the load is light and the steam pressure is high; also, with light load and low steam; and with a heavy load with high and low steam. By doing this I am sure the cause of the knock can easily be traced.

With high steam and a light load, the engine will cut off quickly and this will result in little, if any, compression. With low steam and light load the cutoff will be late and enough steam will be admitted to the cylinder to give compression.

With a heavy load the engine has compression enough, owing to the large amount of steam required to do the work.

G. L. K. does not state whether the knock is on the high or low-pressure side, or what receiver pressure he carries with the different loads and with varying steam pressure. Nor do we know if the vacuum is the same at all times.

If the knock is on the high-pressure side, try raising the receiver pressure to give that side more compression; if on the low-pressure side, lower the receiver pressure, and by so doing, a greater volume of steam, although at a lower pressure, will be admitted, and this will give the low side a little more compression.

If an indicator is not easily obtained, try giving the exhaust valves more lap on the side where the knock occurs. Loosen the lock nuts on both exhaust valve radial rods and while the engine is pounding, turn the rod slowly and note the effect on the sound. Count the turns or parts of a turn so that you can come back to the first point if desired. A. G. Solomon.

To True Up Rim of Flywheel

In the Jan. 15 issue of Practical Engineer, I noticed an account by G. R. S. of how he had trued up a bad flywheel. The editor affixed a note saying it seemed like a bad and rather dangerous practice. I quite agree with him as to most cases.

I have seen this done only once, and that by the engine builder himself. It proved to be a decided success and the method saved a deal of time, special equipment and work.

The engine was a single-valve, side-crank type of 150 hp., with extended shaft for direct-connected generator. Contrary to the usual custom for wheels of this size (about 5½ or 6 ft.), this one was cast whole instead of in halves, so to take the wheel off for truing would have taken a great deal of labor and special equipment.

The wheel wabbled badly and the engine had always given much trouble from heating in the main bearing and crankpin bearing, as well as the wrist pin if the 2 latter were set up properly. The engine made so much noise that the engineers were actually afraid of it.

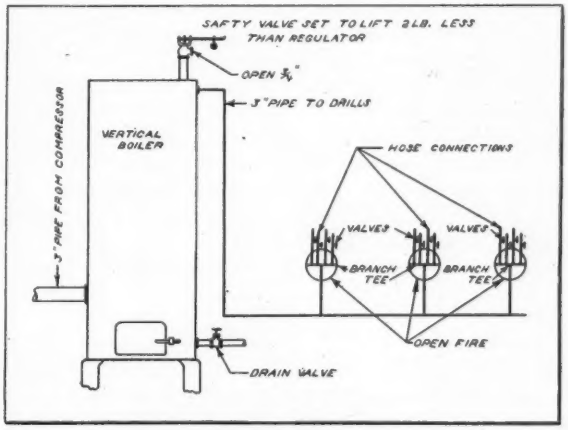
The shaft had been dropped from the dray upon which it was hauled to the plant from the car, so everybody thought it was sprung, and the contracting erectors hardly felt disposed to make this good.

The engine was in a state institution and after the usual 2 or 3 yr. of red tape and delay, the board of control decided they would pay for any repairs necessary, so one of the builders' experts came to look it over.

He found the shaft less than 1/1000 in. out of true and that the trouble was due almost entirely to a warped flywheel. He used a black ash block and a 13 or 14-lb. sledge to pound with. After the valve had been perfectly fitted and a few minor repairs made, the engine was started up, and when I was there recently I was told it had been run a good share of the time for the 3 yr. since; it was still running as nicely as any engine I ever saw. H. U. C.

Reheater Problem

In Dec. 1 issue, page 1148, J. H. A. asks whether a reheater at the end of the air line would help matters. This would give him drier air at drills; that would help him if he is troubled with frost at the drills. Enclosed is a sketch of the supply to drills and hammers at a plant where I was working a few years ago. We used to work out in the dock when it was as low as 10 deg. F. below zero and our load was very changeable. The pipe line



REHEATER PIPING

came from the compressor room to a vertical reheater, There was a small safety valve which was set to lift at 2 lb. less pressure than the regulator at the compressor was set for. When all the load was thrown off at once this safety valve would let out a little air which would be equal to a small number of the drills at work and the regulator would work a little steadier; that is, it would not shut off the compressor so suddenly.

J. S. Bell.

How Rope Drives Wear Out

It seems that some engineers entertain the belief that a power transmission rope will display external evidence of wear before failure is imminent. It is well known that ropes seldom fail because of surface wear. Failure usually begins at the core, where the severest rubbing of fiber against fiber occurs. Examine almost any rope that has failed through wear, and the core and other internal fibers will be found worn into short lengths or in weak condition. In many cases the failed rope is found to contain a fine powder—the result of grinding in the core.

Although it may seem plausible that where the rope is kept perfectly dry (not treated at all) short lengths of fiber will gradually wear through the rope walls and appear on the surface in a brush-like form; but such is rarely, if ever, the case, principally because ropes are usually treated with a dressing of some kind that tends to keep the outer layer impenetrable, and, further, because short lengths that might get started on an outward journey are worn to short lengths before they progress very far.

A transmission rope in operation should appear smooth and polished on the outside at all times. If the rope assumes a brushy appearance the engineer can be assured that there is something wrong with the drive.

Where wear in the core is excessive the rope will decrease in diameter considerably, often noticeably, and that is usually the only external evidence of internal wear.

Of course, there is bound to be some external wear due to the constant rubbing of the rope against the sheaves as it comes into and out of contact, and due to the slight creep that doubtless occurs; but this external wear is slight compared to the dangers that lurk on the inside where the rope is improperly cared for. The best way to care for the rope is to use a penetrating treatment that will get into the rope and surround and lubricate the core fibers to such an extent that the grinding action will be eliminated. Most rope manufacturers now treat their ropes thoroughly in this manner before allowing the ropes to leave the factory. It is incumbent on the engineer or rope man to keep the rope in its initial lubricated condition.

W. F. SCHAPHORST.

Was It Water?

A FRIEND of mine had an experience with 2 engines a short time ago which seems rather mysterious. There are several engines in the plant, but only one was running at the time. The exhaust steam is used in a closed heater and about 2 in. of vacuum is carried. The steam line is of ample size, and dripped at each branch and turn, or about every 10 ft., to a Holly receiver in the basement; also, there is a separator at each engine which is drained by a 1-in. line to the Holly, the valve of which is always left open. The exhaust line is laid below the floor and drained to a drip pocket, where it rises to the heater. The condensation was taken care of by a single-cylinder pump, which was running as usual, and later examination showed it to be in good working order. The engines are of the Corliss 4-valve non-releasing type, and run at 200 r.p.m.

Engine No. 4 had been running all day, carrying about ¾ load, which at 4:30 p.m. was cut down to about ⅓ load. At 4:45 p.m., the engine showed signs of labor, and a grinding sound was heard in the cylinder, which the engineer thought at the time was a dose of water, and for some reason decided to change over to another engine. He opened the throttle of No. 3 engine to put it in service, and had gotten it up to speed when he heard a noise that he said "sounded like a gas engine back firing." The throttle was closed, and after looking around he found that the steam valve stem on the crank end was twisted in the valve rod head, also the steam eccentric rocker arm was twisted on its shaft which operates the valve cams. Both heads that slipped were clamped tight with a draw bolt through the split end, and held by set screws which cut into the shaft in turning, showing that they were not loose. This shows that a severe strain was put on the valve in some manner to cause both arms to slip. The first thought on examining the valve gear was that a bolt or nut in the steam line had dropped into the steam chamber and caught in the valve and port, but the valve was taken out and its edges were found smooth, with no evidence of anything having been caught, which would have at least left a dent on the edge of the valve. The valves were reset by the indicator and the engine runs now as well as ever.

The question is: What caused the valve and rocker arm to become twisted on their respective shafts unless something caught in the ports? How would it be possible for water in the steam line or exhaust pipe to trap in such a manner that the steam valve could be twisted? The boilers were working at about ¼ load at that time, as it was between the 2 heavy load periods. The feed water is controlled by a good regulator and was carrying about 2½ gages at the time, the boilers are clean and have never been known to prime, surely not at ¼ load; the Holly drain system would have to be nearly full of water to affect the engines, and was in good working order at the time with the 1-in. drip connections to the separators open, and the relief cocks on No. 3 were open in starting up. The engineer said it was water in the cylinder; but under these conditions, how could water get into the cylinder, and especially in quantities large enough to do any damage to the steam valves? When the load was reduced on the engine that was running, it was still heavy enough to prevent the expansion line from forming a loop or going below the pressure in the exhaust pipe, although water might have been drawn into the cylinder of No. 3 from the exhaust pipe, if there was any water in it, which was being started.

There have been times when, on account of the exhaust pipe drip pump stopping, water would collect in the exhaust pipe; when this does happen it becomes evident at once, as a violent rumbling and hammering takes place at the tee where the pipe rises to the heater and at the point at which the drip pump is connected. This noise was not heard by those present at the time of the trouble, and the pump was working as usual. There has been a good deal of discussion on the matter, and the cause of the trouble has been laid to water by some, for want of a better reason. It might be possible that water in the exhaust pipe did it, if it was done by water at all, although my opinion is that it was caused by something else. Could it have been done by starting up too quickly, and, if so, how would that do it? I believe that this is a case where "water in the cylinder" has been given credit for doing damage that it was not to blame for, and it was laid to water for want of a better reason. The reason I have gone so deeply into detail in this case is that it supports the statements I made some time ago that "water in the cylinder" was used as an excuse in many cases of engine trouble, instead of the real cause, which sometimes is not easily located.

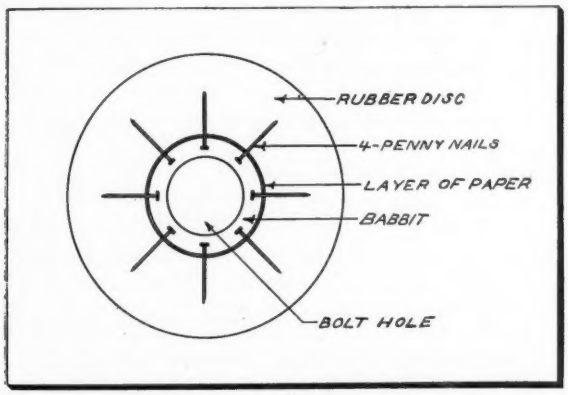
J. C. HAWKINS.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Repair for Rubber Valve Disc

WHERE THE rubber valve disc in an air pump has had the bolt hole worn too large, I have used the following scheme for making the repair, which works satisfactorily. Line the hole with paper and drive several 4 or 6-penny nails, as illustrated herewith, so



REPAIRED AIR PUMP VALVE DISC

that they will come nearly up to the bolt hole. Fill the hole with babbit and rebore to proper size for bolt. The object in putting the paper around the holes is to prevent the babbit from scorching the rubber.

JULIUS W. NOLL.

Formula for Soldering Solution

THE FOLLOWING gives the formula for a solution which is inexpensive to prepare and will be found a great improvement over the soldering acids generally used in machine shops. In addition to being an excellent soldering solution for brass, copper, tin and bronze, it may also be used as a flux for soldering galvanized iron. The union between the galvanized parts is perfect when this flux is used.

The method of preparing is as follows: Make a saturated solution of zinc chloride by dissolving as much zinc chloride as possible in water. Ammonium chloride (ordinary sal ammoniac) is added to this, the quantity being 1/10 part by weight. The solution should be thoroughly mixed before using.

A good paste for use where soldering acid would be objectionable is composed of the following ingredients: Ammonium chloride 25 per cent; alcohol (wood or grain) 25 per cent; common vaseline 50 per cent. The ingredients are thoroughly mixed before the paste is used.—"Machinery."

Repairing A Pulley

AN OLD belt-driven dynamo, which was used for lights and power when the main unit was shut down for cleaning or repairs, was in service when the set screws on the pulley came loose and the pulley came off and fell to the cement floor and broke a piece out of the rim, as shown in Fig. 1.

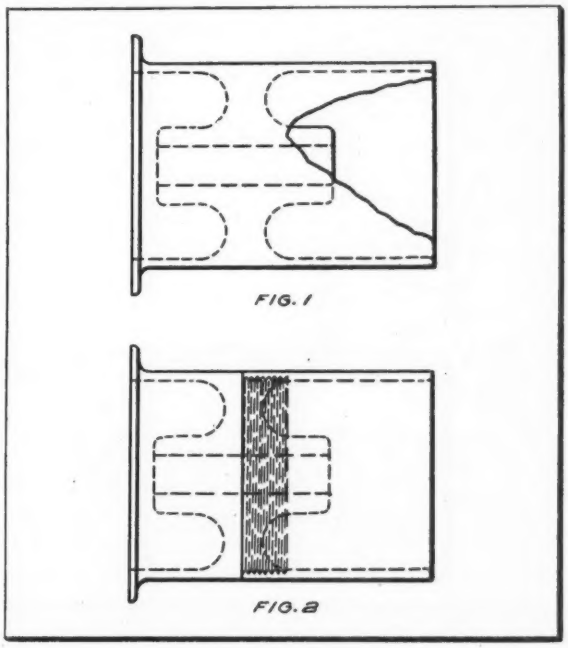


FIG. 1. BROKEN PULLEY
FIG. 2. METHOD OF REPAIRING PULLEY

Figure 2 shows how it was repaired. The pulley was put into a lathe and the broken part of the rim was turned off. Then a cut of about 1/8 in. was made on the surface of the pulley to the center of the hub, and threads were cut. A piece of the same diameter was threaded on inside at one end and screwed on. The threads were cut so that the pipe screwed on the same direction the pulley traveled. The surface of the pipe was then turned up smooth with the other part of the pulley.

This pulley was used as long as the dynamo was in service, which was several years. L. K.

THE CONTRACT for the building of the new municipally owned electric light plant at Fayetteville, N. C., which is to cost $50,000, was recently awarded to J. B. McRary & Co., of Atlanta.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Cutting Keyways on a Lathe

WILL YOU please explain how to cut a keyway on a lathe? D. H.

A. There are several methods by which a keyway could be cut in a lathe, the 2 most commonly used being illustrated by sketches herewith.

Figure 1 represents the shaft clamped on V-blocks along the cross feed carriage and the use of an end mill caught in a chuck in the live head. The end mill would be simply a 2-lipped cutter as indicated on sketch. Of course care must be exercised in this method to have the packing under the V-blocks sufficient to bring the shaft on a common center with the center of the cutter. A hole is drilled at each end of splineway, one to start the cutter in, the other for run-out.

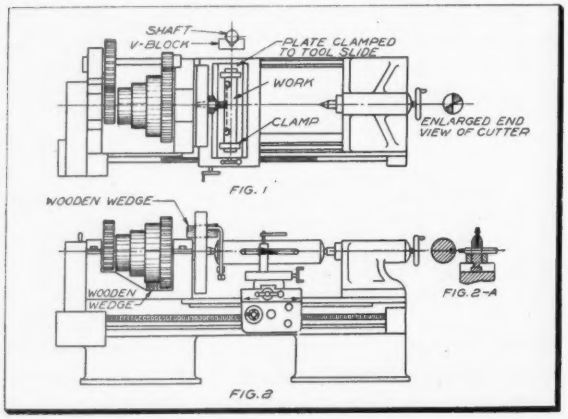


FIG. 1. PLAN SHOWING SHAFT CLAMPED TO CROSS FEED
FIG. 2. ELEVATION SHOWING SHAFT HELD STATIONARY BETWEEN LATHE CENTERS

Figure 2-A is a more common method and one that is used in a great many shops today where they are handicapped for machine facilities. The tool is clamped flat in the tool holder, adjustment being made to have tool on the center of shaft. Shaft is held between the centers of the lathe, and the tail of the dog wedged in face plate to prevent any lost motion. The cone pulley is also wedged with a wooden block to keep it from turning. Holes are drilled in the shaft at distances required by the length of the key seat and the tool is fed back and forth by hand along the ways of the lathe by means of the carriage.

There are other ways of using a lathe for this purpose, but they are not common, and besides where they would not have machine facilities of the ordinary kind they would not be apt to have portable fixtures, hence I have not gone into detail as to the others.

W. J. KAUP.

Points Concerning Operation of Pumps and Boilers

HOW WOULD it affect the action of a duplex pump if lap were added to the steam valve? Would the pump work?

2. If one of the water pistons or plungers would break off, could pump be operated? How?

3. If boilers were foaming violently and you were obliged to keep the engine running, what precuation should you take?

4. How would too much air admitted to the furnace affect the fire?

5. Why are not the bottom of front and back heads stayed like the top? J. W. S.

A. If lap were added to the steam valve the piston would not make a full stroke, and could not be started without moving the valve, because all the ports might be closed at the same time. All the ports cannot be closed at one time when the pump is running on account of the lost motion in the valve stems which prevents this condition. The short valve and lost motion on the stem causes one piston to remain stationary until the other has made its stroke, which prevents 2 strokes being made at the same time, and gives a more steady flow of water.

2. Yes, the pump could be operated one sided at slow speed, but the broken side would work with a jump and might cause the steam piston to strike the head. If it were to be operated this way very long, the lost motion on the broken side should be increased to give more cushion and help to make it run more steadily.

3. If the boilers were foaming I would blow them down with the surface blowoff, keeping the feed pump running. If there are more than one boiler on the line, I would slack the fire on the one that was giving trouble for a few minutes and use the surface blowoff several times, at the same time feeding strong to keep up the water. Doing this will change part of the water, and tend to work out the cause of the trouble. Wash the boiler out at the first opportunity.

4. Too much air admitted to the fire will lower its temperature and cause a loss of heat delivered to the boiler due to the heat lost in heating the excess air that goes up the stack. If air is coming through holes in the fire the spots will appear darker than the rest of the fire, and are at a lower temperature. The flue gas analysis taken when too much air is admitted will show a higher percentage of O and CO, and not enough CO_2. As all the oxygen in the air admitted is not consumed on account of lack of time for mixing in the furnace, some excess air is necessary when the boilers are run at full load but this should not be over 35 per cent in excess of the theoretical amount.

5. If through braces were used below the tubes to stay the heads it would be impossible for any one to get into the boiler to do any work; also the space where the through braces would be attached is taken up by the manhole which has a heavy ring riveted around it, or the plate is flanged in to give it extra strength. Another reason is that the tubes are placed so close to the bottom of the head that there is little area in the heads below the tubes that require to be stayed, and the same kind of staying is not required. J. C. HAWKINS.

Diagram Criticism

ACCOMPANYING indicator card was taken from our engine, which is a 9½ by 12-in. Armington and Sims. Kindly give your advice in regard to changes of setting. G. W. W.

A. I should say that this is a single piston valve engine taking steam from the inside of the valve. The only adjustment that can be made is in changing the length of the valve stem unless the design of the valve is changed. The diagram shows a mean effective pressure of 26 lb. on the head end, and 29.5 lb. on the crank end. As the valve takes steam on the inside, the valve stem should be lengthened a little to equalize the cutoff and balance the work in the 2 ends of the cylinder. This will also equalize the compression which is greater on the crank than on the head end.

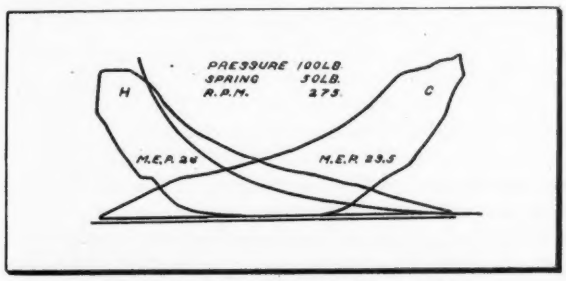


DIAGRAM SHOWING LEAKING VALVE

With a single valve it is impossible to get all the events of the stroke as they should be, and correcting 1 fault may make another worse. I have traced the theoretical expansion curve on 1 end, which shows that there is considerable valve leakage into the cylinder during the expansion part of the stroke. Possibly the engine has been running a long time and the valve is badly worn. I would suggest that you block the valve in the center of its travel and open both indicator cocks and turn on steam carefully. If it escapes from the indicator cocks it shows that the valve leaks. The piston may be tested for leakage by admitting steam to 1 end through the valve with the indicator cock on the opposite end open and the wheel blocked to prevent its turning. This of course must be done carefully and the wheel securely blocked. The horsepower of the diagram is 32.8.

If the load could be increased a little, giving later cutoff, the engine would be more efficient than it is at present. If the exhaust steam is used for some purpose such as in the heating system or drying, the valve leakage is of little importance as steam is not wasted, but if the engine is exhausting to atmosphere part of the time, it should be looked after at once.

Grouting An Engine

I AM in charge of 2 twin compound pumping engines, and find 1 of the engines out of line. I desire to raise the pump end ½ in. in order to bring it in line after raising the engine bed and thought sulphur would be a good substance to fill in on top of the foundation. Could you inform me the best way to go about my job? That is, would you melt the sulphur in a ladle and pour it just as you would lead? After melting do you have to pour it quick right from the ladle or may it be dipped from the ladle, and does it require much care to prevent it from igniting while melting?

If you know any substance which is superior to sulphur in durability and task, I will be obliged for information. W. V.

A. If you desire to use sulphur to grout in under your pump after raising it, it is absolutely necessary to have the foundation free from oil and grease and dry. The size of the ladle in which the sulphur is melted depends all on local conditions, whether it is possible to get in around the work with a large ladle full, enough to do a large amount of grouting.

Sulphur should be melted in a closed vessel in such a manner as to keep the direct heat of the flames from coming up around the top of the kettle or ladle. A round bottomed kettle on an old stove makes a good outfit. If an open fire must be used, use a sheet of iron with a hole cut in it of the proper size for the kettle or ladle.

It can be poured directly from the large melting ladle, or dipped out by means of a smaller ladle previously warmed, the same as is done when dipping molten lead or babbit. Do not get the sulphur too hot or it will not handle well.

Sulphur, however, as a medium for this purpose, has passed on with the rest of the many things which have been superseded by a better substance, and Portland cement has come to be used practically universally for grouting purposes.

Use the same care in removing the oil from the top of the old foundation as with sulphur, washing the chips off with a hose after chiseling off the oil surface. Have the foundation wet when the cement is poured.

Build a dam of wood about 2 or 3 in. away from the edges of the foundation, so that the top will be about 1 inch or more above the bottom of the bed plates. Make this dam tight with sand or dirt banked well on the outside of it to prevent the liquid cement from getting away.

A course of common brick laid in common lime mortar 24 hr. before pouring makes a good dam, and it can be removed as soon as the cement "sets" and the brick easily cleaned off.

When all has been made ready, take equal parts of the best Portland cement and good, clean, sharp sand or fine gravel. Mix well both dry and wet, to the consistency of a cream, in a mortar box set close to the work in such a position that when the slide in the side of the box is opened, the "slush" will flow quickly into place.

Keep it well poured up to the instant of pouring and after pouring, take a small switch, such as willow or

hazel, and work it back and forth in the cement under the casting, to insure that it gets to all parts and that the air is all out.

If it is not possible to arrange the mortar box in this manner, it can be set at some convenient place near by where the mixing can be done and the slush scooped into pails and carried to the job. But keep it well mixed continually till it is all used.

Portland cement has every advantage over sulphur or lead for grouting purposes, as it can be made ready on short notice, and is not disagreeable to handle. After it has "set" for about 2 days, it can be trimmed off around the edges to suit and will naturally finish off level on top, being poured as a liquid.

In a week or so, the wedges can be withdrawn from in under the machine if desired, though it is not necessary that they should be, if the grouting is allowed to rise about ½ in. above the bottom of the castings all around.

By using a thin piece of hoop iron or a similar substance, cement can be worked into very thin places where the bed plate tapers off to meet the foundation.

The writer has grouted a great many engines up to several thousand horsepower with "half and half," as described here, and has never had a failure. In one instance, an engine of about 2400 hp. was drawn down on the wedges with the foundation bolts, grouted and started up within 5 min. and put right on the load, rolling steel while the cement was still plastic enough to work with a trowel. This was an exceptional case, but it is best to let the grouting set at least a week before placing the engine or pump in service.

Boiler Compound

I READ with interest the article "Scale in Boilers," on page 1110 of the November 15 issue of Practical Engineer, by Geo. H. Wallace, and would like to have Mr. Wallace answer the following questions for me, if convenient:

He states than he had 2 300-hp. boilers and used 3 pints a day, one morning, one noon and one evening. Were the 2 boilers together rated at 300 hp., or was each boiler rated at 300-hp.? The compound used is certainly a small amount, and I would like to know if that mixture would work with other waters.

I have a 125-hp. boiler, but we get about 75 hp. from it, and sometimes about 80 hp. Now, I have tried all kinds of compound, and have paid as high as 10c. per lb. for it, but with no good results. Then I made a mixture of my own as follows: 5 lb. of catechu, 5 lb. of sal ammoniac, 50 lb. of sal soda. This I dissolved in 48 gal. of water, using 3½ gal. a week in a compound feeder, and it gives the best results.

I would like to try Mr. Wallace's compound. He states 4 lb. of tannic acid. What kind of an acid is this? Now, catechu is an acid extracted of bark and comes from India in big chunks. It has a dark brown color and is very hard to dissolve.

Would you advise using 1 pt. a day of your compound for 80-hp., or just what quantity would you advise using? R. E. K.

A. The boilers referred to in your inquiry are of the horizontal water-tube type of 300 rated boiler horsepower each. Possibly the amount of compound used per day as referred to in the article in the Nov. 15 issue of Practical Engineer may seem small to some, but there were some returns from a number of traps and also from the heating system and other sources from the manufacturing end of the plant.

In regard to the tannic acid referred to, it is a product of a number of different kinds of bark such as oak, elm, willow, horsechestnut, and also from a number of shrubs or bushes through the leaves, such as sumach, whortleberry, etc. Coffee and tea contain a small amount of tannin, as do also the roots of a few trees.

The bulk of commercial tannic acid is obtained from gallnuts, and is in the form of a coarse flaky powder, not much unlike pulverized glue in looks, being of a yellowish color. The chemical formula for this kind, called gallotannic acid, is $C_{54}\ H_{22}\ O_{34}$, while that for mimotannic acid, the kind you use and obtained from the catechu tree is $C_{54}\ H_{24}\ O_{24}$. While the carbon remains the same, there is a slight difference in the proportions of hydrogen and oxygen.

Tannic acid has a strong astringent taste which is similar to the taste of the bark of a cherry tree or a willow in the springtime. It can be bought at almost any drug store at from 90c to $1.15 a lb., depending on location and the quantity purchased.

The catechu which you use is sometimes called "logwood" and is strong in tannic acid. In your location, the water is liable to be of a somewhat different character from the lake supply, such as we have here, and may require a little different treatment. While the right quantity of our compound is difficult to prescribe to meet your requirements, we would not advise the use of more than a pint a day at first, making note of the results every week if possible.

Much care should be exercised in these matters so as not to precipitate loose scale to the bottom of the shell where, in a tubular boiler, it is liable to cause a bag.

Of course it must be understood that there is no formula for compound which acts directly on the water, that is universally successful in different parts of the country, owing to the fact that the water is so different chemically that different remedies must be used to counteract their action in a boiler. So give the matter careful thought and study and watch the situation closely and you will be able to keep your boiler free from scale. GEORGE H. WALLACE.

ROANOKE RAPIDS POWER CO. has begun the erection of a new electric light and power system in Roanoke Rapids, N. C., having been granted a franchise by the town commissioners several weeks ago, as the old power company had forfeited its franchise. J. T. Chase, the local manager, says that he will rush the completion of the new plant as rapidly as possible. The rate for lights will be 10 cents per kw.-hr., with a 25 per cent discount provided the bill is paid in 10 days, which will make the actual cost to the consumer only 7½ cents. The power rate will be in keeping with the low light rate.

OUR DOUBTS ARE TRAITORS and make us lose the good we oft might win, by fearing to attempt.—Shakespeare.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Taking the Examination

One of our firemen took an examination for a third-class engineer's license and failed. We were all surprised, for we had been coaching him for a year and thought he was perfect; but the inspector thought otherwise.

We told him not to worry, as we would try to fill his head so full of engineering knowledge in the next 90 days (this being the time that one has to wait in this state before he can take another examination after being refused a license) and that when he went before the inspector again, the inspector would not be able to stick him; but when he went after his application blank he told the inspector what we said and the inspector remembered both him and ourselves when he had him before him to be examined and he confused him so badly that he came back with the impression that he knew nothing, whatever the ones who had been trying to teach him might know about the subject. The first question he was asked, was, "What do you know about a slide valve?"

The fireman answered, "All that can be known."

"How would you set the slide valve to run the engine in the opposite direction?" was the next question.

The answer given was the old formula, "Put the engine on the dead center, loose the eccentric on the shaft and turn it round the shaft in the direction it had been traveling until the valve traveled over the ports and back to its original position, then turn it backwards until the lead is the same as it was before and the engine will run opposite to what it did before." Then the inspector proceeded to confuse him:

"You have the same lead, the valve opens the same port at the same time and the engine runs backward. Why does it?" The inspector scored this time. Then he asked, "If you were running a Fitchburg engine, and the spring on one of the governor weights broke, what would happen?"

"The answer given was, "The engine would slow down."

Then the inspector asked, "If the link that holds one of the weights to the governor eccentric broke, what would happen?" Again the inspector scored.

Then he asked, "If you were running a high speed engine with a governor in the flywheel and the wheel got broken so you had to have a new one, how would you balance it, with the governor or without?" Third score for the inspector. Then he asked, "If you had to put the try cocks in a water column according to the Massachusetts law, where would you put them in relation to the gage glass?"

The answer given, "I would put the lower cock 2 in. above the top of top row of tubes and the others 3 in. from each other above that." Score 4 for the inspector.

He asked, "If you divided the crank circle into 4 equal parts, over which 2 parts of the circle would the piston travel the fastest?"

The answer given was, "The first and third, because that is where she takes steam." See diagram. The inspector told him to look it up and come again in 3 months' time. When the fireman came back he told us that when

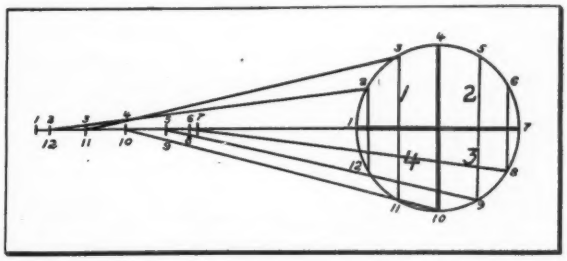


DIAGRAM SHOWING RELATION OF CROSSHEAD TRAVEL TO CRANKPIN POSITION

he wanted any information on steam enginering he would write to Practical Engineer for it. We thought that the inspector was wrong in the last question; but when we made a diagram and studied it over a few times, we came to the conclusion that he was right, and that we did not know it all; but we would like to hear from Practical Engineer readers, on the questions.

J. E. K.

Heating Surface Required

Replying to A. L.'s question, in Jan. 15 issue, on heating, computing loss of heat through wall and glass, and allowing for reheating, if steam is off at night, considering it as the top floor, allowing for leakage through roof and 4 exposures, I think 3087 lineal ft. of 1½-in. pipe would be about right. If steam is kept on at night, 2780 will do; this will give him, in the first instance, 1534 sq. ft. of heating surface, and in the second case, 1382 sq. ft.

I think a 2-in. pipe ought to be sufficient to reducing valve.

Wm. C. Cheddeck.

Arma, Kan., was recently filled with strangers, who were there to represent their bids on a municipal water and light plant to be built soon. The Commercial Construction Co., of Kansas City, secured the contract for building the entire plant for $31,700. They give bond to have the work completed within 4 months after starting.

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Uniform Boiler Specifications

At a meeting of the American Boiler Manufacturers' Association, held in Cleveland last September, a paper was read by Thomas E. Durban, of the Erie City Iron Works, giving in detail the history of the effort for uniform boiler specifications throughout the country, and calling attention to the great variety of laws in force and being proposed, from different states and cities, and to the varying interpretation put on these laws and rules by different inspectors. As an instance, he commented on the butt strap joint requirement, where the wording says that a butt strap joint may not be over 12 ft. in length, and some inspectors have held that this applies to all boilers, while other inspectors have permitted the use of butt straps up to 20 ft. in length, in the drums of water-tube boilers. Mr. Durban also showed the confusion that arises in shops where boilers are being made for different localities, because of the varying requirements in regard to materials, and details of construction. The stress allowed in material of braces varies from 6000 up to 8000 lb. per square inch, and there is great difference in the practice in regard to lap joint seams. Also there is confusion in regard to the specification of the brand for materials in different parts of the boiler, and there is great variation in the materials found on the market under the brands "firebox" and "flange," some of the flange steel coming up to the requirements of firebox in all respects. In Mr. Durban's opinion, the best steel is needed where the stress is greatest, as in the heads which are flanged, and it would be better if the rules called for flange steel in the shells and fireboxes, and firebox steel in the heads.

In closing his paper, Mr. Durban recommended the adoption of rules calling for a minimum tensile strength of 60,000 lb. per square inch, the passing of the bending and quenching tests, a specification for phosphorus not to exceed 0.03, sulphur not to exceed 0.04, and manganese not to exceed 0.05. He recommended also, weldless, crowfoot braces of the same steel as the plate, and an allowance of 7500 lb. per square inch of cross section, with no brace having a section over 1.28 sq. in. Through braces to be weldless, and on the same basis for tensile strength. He recommended that manholes be 11 by 15 in., that all seams be butt strapped, inside and out, that no plates over ⅝ in. thick be allowed in a tubular boiler, that all rivet holes be punched ¼ in. small and reamed to size, that flue holes be punched ½ in. small and reamed to size, that no cast iron be permitted in the construction of any tubular boiler, that all plates be beveled on a planer, that water column connections be not less than 1¼ in., and that a committee be appointed with power to act, to bring together boiler makers, steel makers, state and city officials, and representatives of boiler insurance inspection companies, within 60 days of that meeting, to discuss rules and regulations.

In accordance with this plan, a meeting of a National Committee on Standard Specifications for Horizontal Tubular Boilers, was held in Pittsburgh, October 30 and 31, at which there were present inspectors of boilers from Detroit, Philadelphia, Chicago, Seattle, the Ohio State Board, and various insurance companies; repre-

sentatives of the Ohio and Massachusetts Board of Rules; representatives of boiler manufacturers and industrial commissions. A full and complete discussion was held for 2 days, and at the end, after threshing out all points, the following recommendations were unanimously adopted:

1. A factor of safety of 5 to be used on all parts of the boiler. 2. Fusible plugs to be used in all boilers. 3. All rivet holes to be reamed; plates up to and including 5/16 in. thick to be reamed 1/8 in.; from 5/16 in. to 5/8 in., to be reamed 1/4 in.; and above 5/8 in. to be drilled from the solid. 4. Tube holes to be cut from the solid or punched 1/2 in. small and reamed to size. 5. Allowable pitch for diagonal braces in a boiler to be the pitch of stay bolts, plus 2 in. This pitch to be taken from center to center of rivet. 6. Through rods to be pitched the same as diagonal braces. 7. When the boiler has a manhole, the front head or rear head can be braced with crowfoot stays, and can be triangular if properly distributed, but the bridge type of brace for rear head is preferred. 8. Longitudinal seams of the shell to be butt strapped in all cases, except boilers under 36 in. in diameter, and carrying pressure not exceeding 100 lb. Thickness of butt strap as recommended by the Massachusetts Board of Boiler Rules. 9. Boilers 40 in. in diameter shall have a manhole above the tubes, and boilers above 48 in. diameter a manhole below the tubes. All boilers not having a manhole shall have a handhole in the front head. 10. Perforated, dry pipe to be prohibited, and slotted or channel dry pipe to take its place. 11. Boilers above 72 in. in diameter to have gallows frame suspension; those 72 in. in diameter or less, to be supported by brackets. 12. Internal feed pipes to be used, as per the Massachusetts rules. 13. All plates to be beveled on a regular plate planer where possible, and no process to be used in beveling plate that causes distortion at the edge. 14. Inspectors to be authorized to replace obliterated stamps. 15. Blowoff tanks to be made of boiler plate, to stand boiler pressure, with 2 flanges for inlet and outlet. Outlet to be equivalent to twice the diameter of the blowoff inlet. 16. Fitting of butt straps to be made as per Massachusetts Rules. 17. The minimum size of water column pipe connections to be 1½ in.

In regard to the stamping of plates, a further conference is to be held between the plate makers and the committee, the desire of the meeting being that plates be numbered, giving the tensile strength developed in the test, not the minimum, and that the heat number and the specimen number be given, and a record of the test, and both the chemical and physical properties be given by the full certificate on test and analysis, which shall be furnished to state inspectors and the customer. A record of the test and analysis to be kept with the specimen number of the boiler at the factory where the boiler is made, so that at any time, by giving the number, a certified copy of such test can be furnished. This National Committee on Standard Specifications is now in correspondence and conference with the proper authorities in every state, and copies of the report of the meeting have been sent to all governors, to state boards, to boiler manufacturers, and to the heads of departments.

Representing, as they do, the best judgment of men who are best qualified to judge of what is right and safe in boiler construction, the recommendations are worthy of the support of all who are interested in securing the best possible power plant practice, and of all who are interested in advancing the cause of safety as being paramount to every other consideration in the installation and operation of all machinery.

News Notes

AT A JOINT MEETING of the Executive and Show Committees of the National Gas Engine Association, held in Chicago, Jan. 31, it was decided to hold the seventh annual meeting at the La Salle Hotel, Chicago, June 24, 25 and 26, 1914.

Several cities had representatives present, submitting propositions for housing the Third Annual Gas Power Show; but the committee deemed it advisable to have the Show east of Chicago, so selected Toledo, Ohio. An option was secured on the Terminal Building and the dates selected for the Show are October 19 to 24, 1914.

THE KERR TURBINE CO., Wellsville, N. Y., announces that on Jan. 1, 1914, its southern interests were placed in the hands of the International Steam Engineering Co., with main office in the Grant Building, Atlanta, and branches in Realty Trust Building, Charlotte, N. C., and Brown-Marx Building, Birmingham, Ala.

James E. Weinbold will give personal attention to new business in territory including North and South Carolina and Eastern Tennessee; Robert Stevens, to Mississippi and Alabama; W. R. Jennison, to all other Southern territory.

THE MEETING of the Southwestern Water Works' Association will be held at Tulsa, Okla., June 15, 16 and 17. An exhibit of apparatus of interest to water works managers will be held, no charge being made for floor space, and present indications are that there will be a large exhibit and a large attendance. The territory covered by the association includes Arkansas, Kansas, Louisiana, Missouri, Oklahoma, Texas and New Mexico.

M. B. SKINNER & Co. has taken the exclusive Sales Agency for James McCrea & Co., beginning Feb. 1. Mr. Skinner, who has owned the principal stock of James McCrea & Co., for 5 yr., is at the helm of the new concern, and will adopt new lines heretofore not identified with the business. The new firm will be found at 558-562 Washington Boulevard, Chicago, with new offices and increased facilities to handle a larger business.

THE WHEELER CONDENSER & ENGINEERING CO., of Carteret, N. J., has opened an office at 122 Board of Trade Building, Montreal. This office shall be under the management of Jos. McKay, Jr., who has been for several years New York manager of the Wheeler company.

THE ANNUAL CONVENTION of the American Supply & Machinery Manufacturers' Association will be held at the New Greenbrier Hotel, White Sulphur Springs, W. Va., on June 15, 16 and 17 next.

AT BLOOMINGTON, NEB., bonds for an electric light plant, amounting to $8500, carried at an election recently by a vote of 96 to 10.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Thyssen Vacuum Pump

CENTRIFUGAL AIR PUMP EMPLOYING A DOUBLE IMPELLER OPERATING SINGLE STAGE

THIS pump is the design of Thyssen & Co., Mulheim-Ruhr, Germany, and has been in operation in many of the largest power stations of Europe for several years. The development of the Thyssen air pump herein described was due to the necessity of having an efficient high vacuum pump for large turbine units, that would take up little space and be free from the many objections of reciprocating air pumps and at the same time eliminate the shortcomings of some of the centrifugal air pumps already on the market.

A section of the pump is shown in Fig. 1 from which will be seen that the machine is practically a double impeller single-stage centrifugal pump with horizontal divided case. Each impeller discharges into an annular nozzle from which the water emerges in a thin film at high velocity, entraining the air from the condenser through an annular diffuser or conversion throat and discharging the mixture against atmospheric pressure. The moving element consists of 2 single-stage impellers mounted right and left hand on a driving shaft and between them is mounted a disk carrying 2 nozzle rings. There are 4 of these nozzle rings, the other 2 being separate and stationary, one attached to the casing and the other forming a sliding sleeve which is controlled by a hand operated external adjustment that can be moved axially, thus varying the width of opening between the rotating and stationary rings to regulate the quantity of water for a given speed and temperature of entraining water.

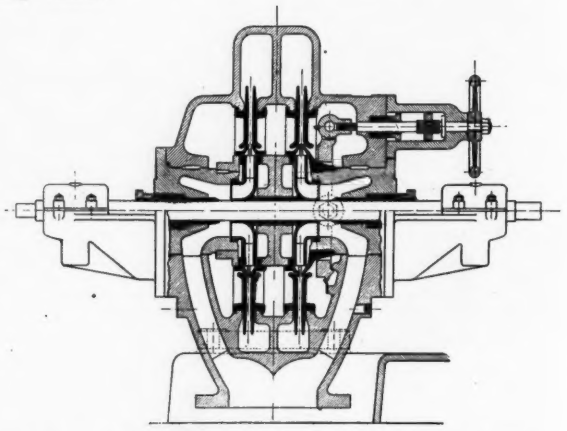

FIG. 1. SECTION OF THE THYSSEN VACUUM PUMP

The action of the pump is as follows: The entraining or "hurling" water is drawn into the pump, as in an ordinary centrifugal pump, and discharged by the impellers in 2 parallel films. Each discharge nozzle consists of a stationary and a revolving ring, by which the particles of water are given a swirling movement which greatly increases the air entraining effect of the water

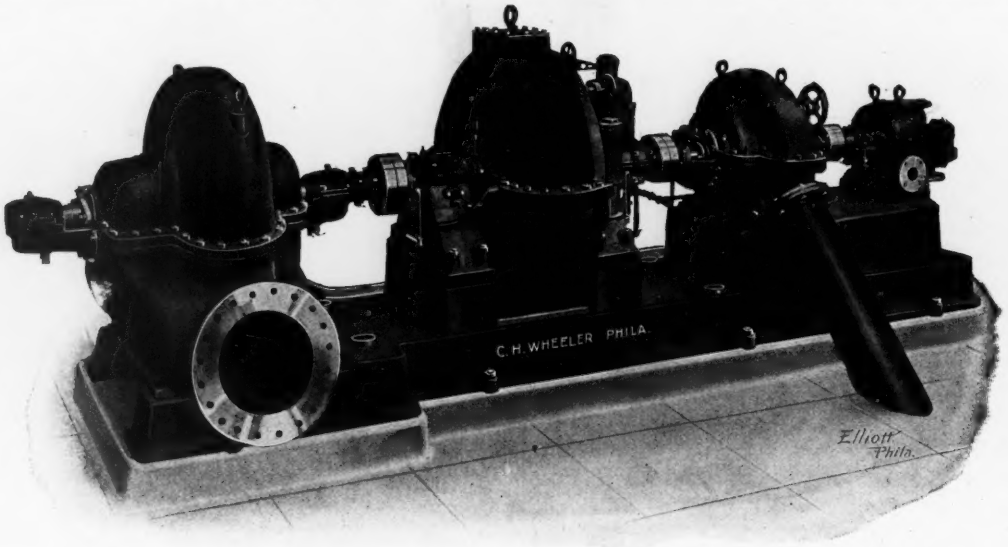

FIG. 3. PUMPING OUTFIT FOR SURFACE CONDENSER

leaving the nozzle rings. It should be noted that, to permit the impellers to retain their central position under the nozzle rings with varying positions of the adjustable ring, a small lateral movement of the nozzle ring is immediately followed by a movement of the shaft endwise, bringing the pump instantly into hydraulic balance by discharging the water pumped by the 2 impellers through the annular openings of equal width between the 2 sets of nozzle rings. The pump is commonly located over a small tank as shown in Fig. 2, but can be arranged to draw and discharge the entraining water in parallel with the circulating pump if preferred.

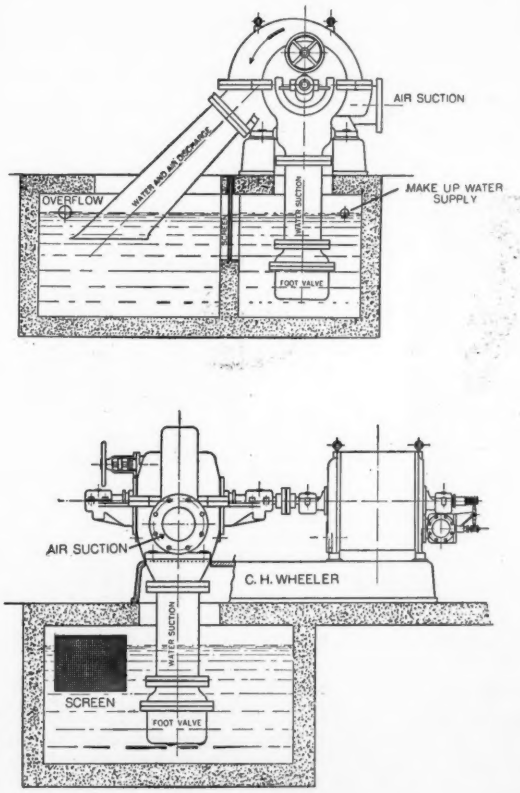

FIG. 2. COMMON METHOD OF INSTALLING THYSSEN VACUUM PUMP

These pumps are built for a wide range of capacities; speeds from 1000 to 3000 r.p.m. being permissible, permitting either economical turbine drive or slower speeds to suit motors.

Many attractive pump combinations for surface, jet and barometric condensers are possible with this machine as in Fig. 3, where the circulating, Thyssen air and centrifugal hot well pumps for a surface condenser taking care of a 3500-kw. steam turbine, are shown; the compactness and simplicity of the design are obvious.

The C. H. Wheeler Manufacturing Co. advise us they have acquired the sole manufacturing and selling rights for the Thyssen pump in the United States and Canada. They are built in sizes up to 15,000-kw. capacity in one unit.

Elliott Separators

IN order to comply with the 1912 standard, adopted by the American Society of Mechanical Engineers and the Master Steam Fitters Association, the flanges on the Liberty-Greenaway separators have been redesigned, and further improvements of a minor nature, relating principally to the method of reinforcing the flange in the high-pressure types have been made. The

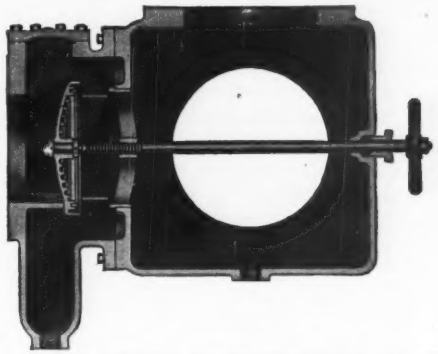

FIG. 1. SECTION OF TEE VALVE SEPARATOR AS ARRANGED FOR HORIZONTAL EXHAUST MAIN

Liberty-Greenaway separators, after undergoing the redesign and improvement, are now known as the Elliott separators.

Additions have been made to the standard line by the development of combination separators for use in connection with low-pressure heating and drying systems, feed-water heaters, etc., the object being to pro-

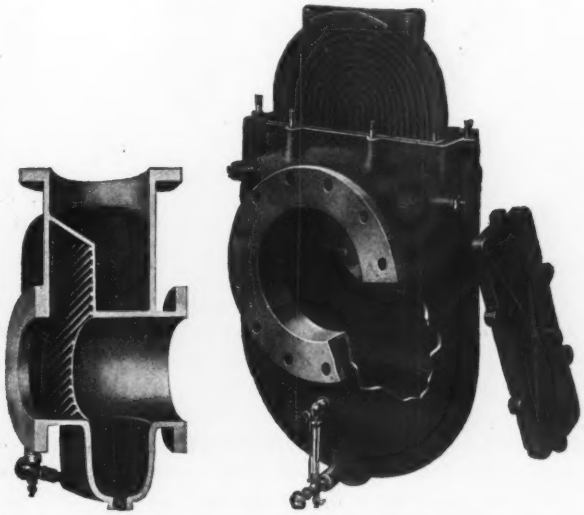

FIG. 2. SECTIONAL VIEW OF THE TEE SEPARATOR SHOWING INLET AT THE LEFT

FIG. 3. ELLIOTT TYPE O OIL SEPARATOR SHOWING INTERIOR AND METHOD OF REMOVING BAFFLE

vide apparatus that will reduce the cost of piping and enable the designer to locate the heater and the connections to the heating or drying system at more accessible and convenient points than was heretofore possible with standard separators.

Combining a tee, a valve and a separator in one fitting, the tee valve separator is designed for use in

connection with exhaust-steam heating systems, low-pressure turbines and for any service where it is desired to eliminate the oil and entrainment from a part of the exhaust steam. Such an arrangement economizes space and cost of installation in its application to various low-pressure piping systems.

The separator is attached to the side of the tee, and performs the functions of both separator and valve. The separator plate is of the impact type, concave in form, with annular corrugations. It is mounted on the valve stem, directly opposite the opening in the tee, requiring all the steam passing through the separator to impinge on the corrugated surface which catches the oily entrainment and deposits it in the receiving chamber directly beneath.

Inasmuch as oil and other entrainment in the steam will, in time, adhere to the separator plate, provision is made for removing the plate for cleaning. After removing the cover of the separator proper, the opening is amply large to permit the removal of the plate when the valve stem has been withdrawn. This can be accomplished without disturbing any piping connections. This separator is adaptable for use in either horizontal or vertical pipe lines.

Another form is the tee separator, embodying both a tee and an oil separator, making a combination fitting designed to eliminate the oil and entrainment from the exhaust steam escaping to the atmosphere or utilized in the heating or drying system.

It performs the function of a tee, as it has 3 flanged pipe connections with a full pipe-size opening between the horizontal inlet and outlet flanges. The steam, escaping through the top opening, must impinge on the corrugated surface of the vertical baffle plate in addition to coming in contact with the outer baffles or deflectors containing the ports. In this circuitous passage from the inlet to the top outlet the steam must make a number of right-angle turns and as the entrainment, including the oil, is heavier than the steam, it will be thrown into the recesses of the baffles and drained to the chamber at the bottom of the fitting to flow to waste. This chamber, besides receiving all the condensate flowing in the horizontal pipe, acts as a receiver for all the entrainment removed by the baffles of the tee separator.

Elliott oil separators are designed for removing oil from exhaust steam in heating and drying systems, feed water heaters, ice plants, paper mills, dyeing establishments, laundries, etc. In the Type O separator steam impinges against the corrugated surface of the baffle plate, then passes to the outlet through ports or openings at the side. The particles of oil are thrown against the baffle plate which is made with vertical corrugations at right angles to the direction of flow of the steam and drains to the receiving chamber below.

Removal of oil from the exhaust steam on its way to a condenser presents difficulties that do not exist with noncondensing systems. The steam being of large volume and low pressure, flows through the pipes at a very high velocity. The vacuum that can be maintained at the exhaust valve of the engine, is dependent in part on the resistance met by the steam in its passage from the engine to the condenser.

To solve this problem, type P separator has been designed with baffles consisting of a double row of V-shaped plates, and the steam, in order to pass through, must make a number of short, quick turns. This action affects the removal of the oil and entrainment. The V-shaped plates, dividing the steam into numerous thin currents, cause the particles of oil and entrainment to come in contact with the plates to which they adhere.

Provision is made in both type O and type P for keeping the baffles wet with jets of water from a spray pipe, if the steam is dry. This arrangement not only assists in the separation of the oil from the steam, but in a measure, prevents the plates from becoming gummed up from continuous use. The cover of the separator is removable, so that the baffle plates can be taken out and cleaned when necessary without breaking pipe connections.

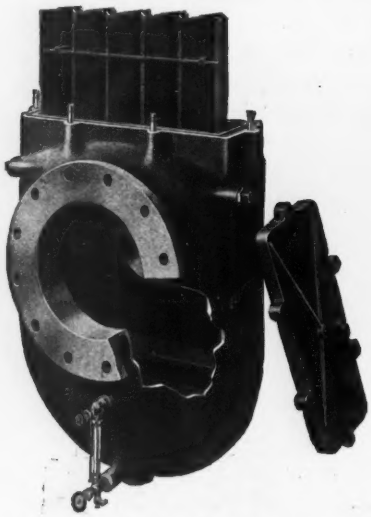

FIG. 4. TYPE P SEPARATOR, ESPECIALLY ADAPTED TO REMOVE OIL FROM EXHAUST OF CONDENSING ENGINES

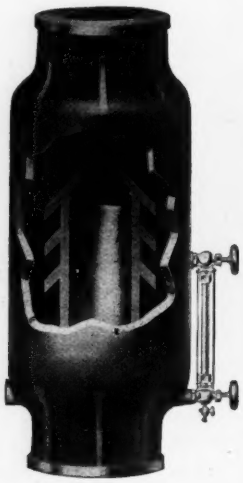

FIG. 5. TYPE AH SEPARATOR FOR VERTICAL STEAM LINES

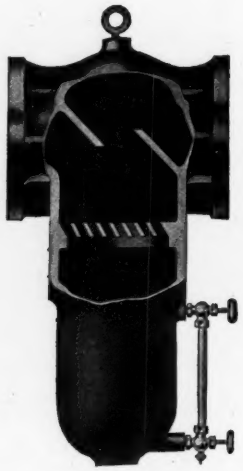

FIG. 6. SECTIONAL VIEW OF TYPE CH STEAM SEPARATOR FOR HORIZONTAL LINES

DIRECTIONS FOR USING ILLUMINATION TABLES

Obtain area of floor space to be lighted and height of ceiling. Note color of walls and ceiling, service requirements and type of equipment.

From Table III determine desirable size of squares at the center of which an outlet is to be located.

From Table IV secure the watts per square foot required to produce one foot-candle illumination.

Table II gives the intensities required for various classes of service in foot-candles per square foot.

The number of outlets is secured by dividing the area by the square of the spacing given by Table III. The area covered by each unit is equal to the square of the spacing. The intensity (from Table II) multiplied by the constant (from Table IV) gives the watts per square foot.

Considering 15 per cent depreciation, due to accumulation of dust and dirt, multiply the watts per square foot by 1.15, giving the watts per square foot that should be provided. This multiplied by the square of the spacing gives the watts per outlet.

TABLE II—FOOT-CANDLE INTENSITIES RECOMMENDED FOR VARIOUS CLASSES OF SERVICE

Armory	2.0 — 4.0
Art Gallery (Walls)	5.0-10.0
Auditorium	1.0 — 3.0
Automobile Showroom	3.0 — 6.0
Bank (General)	2.0 — 3.0
Bank (Desks)	4.0 — 6.0
Billiard Room (General)	2.0 — 4.0
Billiard Table Only	6.0-10.0
Cafe (General Only)	2.0 — 4.0
Cafe (with Table Lights)	1.0 — 3.0
Card Room (Tables)	3.0 — 5.0
Church	1.0 — 3.0
Drafting Room	6.0 — 13.0
Desk	4.0 — 8.0
Engraving	10.0 — 12.0
Factory (General Only)	2.0 — 3.0
Factory (Bench Work)	5.0 — 10.0
Local Bench (Finework)	3.0 — 5.0
Local Work (Coarse Work)	1.0 — 3.0
Gymnasium	1.0 — 3.0
HOTEL—	
Bedroom	1.5 — 2.0
Corridor	.8 — 1.5
Dining Room (General)	2.0 — 4.0
Dining Room (Lts. on Tables)	1.0 — 2.0
Lobby	2.0 — 4.0
LIBRARY—	
Stock Room	1.6 — 2.0
Reading Room (General)	3.0 — 4.0
Reading Room (With Local)	.7 — 1.5
STORES	
Clothing	4.0 — 7.0
Dry Goods	4.0 — 7.0
Furniture	2.0 — 4.0
Grocery	2.0 — 4.0
Hardware	2.0 — 4.0
Jewelry	4.0 — 6.0
Millinery	4.0 — 6.0
Shoes	2.0 — 4.0
Stationery	2.0 — 4.0
Ware House	.5 — 1.0
OFFICES—	
Small Offices (Private)	3.0 — 4.0
Small Offices (General Use)	3.0 — 6.0
Large Office (General Illumination)	3.5 — 5.0
Large Office (With Desk Lights)	1.5 — 2.0
RESIDENCES—	
Hall	.7 — 1.0
Parlor	1.0 — 3.0
Living Room	1.5 — 2.5
Library	1.5 — 2.5
Dining Room	1.0 — 3.0
Kitchen	2.0 — 3.0
Laundry	1.5 — 2.0
Bedroom	1.0 — 3.0
Bathroom	2.0 — 3.0
Store and Furnace Rooms	.4 — .8

PROPERTIES OF SATURATED AMMONIA

By H. J. Macintire, Copyright, 1912, by Refrigerating World, New York.

Temperature.		Pressure in Pounds per Square Inch.		Saturated Vapor.		Liquid	Heat of the Liquid from 32° F.	Latent Heat. $H+q$	Total Heat of Dry and Saturated Vapor from 32° F.	Entropy of Dry and Saturated Vapor.	Specific Heat Saturated Vapor.
	Degrees Fahr.	Absolute.	Absolute.	Gauge.	Volume in Cubic Feet per Lb.	Weight in Lbs. per Cubic Foot	Weight in Lbs. per Cubic Foot				
	t	T	p	p'	v	$\frac{1}{v}$	s	q	r	H	N	cp
	40	500	72.77	58.07	3.976	.2515	39.31	9.035	537.7	546.7	1.095	0.556
	41	501	74.25	59.55	3.900	.2564	.25	10.37	536.8	547.0	1.093	0.557
	42	502	75.70	61.06	3.826	.2614	.18	11.71	535.9	547.2	1.092	0.558
	43	503	77.30	62.60	3.753	.2665	.11	12.45	534.1	547.5	1.090	0.559
	44	504	78.86	64.16	3.681	.2716	.04	13.58	534.3	547.7	1.088	0.560
	45	505	80.45	65.75	3.612	.2768	38.98	14.73	533.3	548.0	1.087	0.561
	46	506	82.08	67.36	3.544	.2821	.91	15.87	532.4	548.2	1.086	0.561
	47	507	83.70	69.00	3.477	.2875	.85	17.01	531.5	548.5	1.085	0.562
	48	508	85.36	70.66	3.412	.2930	.79	18.1	530.6	548.7	1.083	0.563
	49	509	87.05	72.35	3.349	.2986	.71	19.30	529.6	548.9	1.080	0.564
	50	510	88.76	74.06	3.287	.3042	38.64	20.45	528.7	549.2	1.079	0.565
	51	511	90.49	75.79	3.226	.3100	.57	21.60	527.8	549.4	1.078	0.566
	52	512	92.24	77.54	3.167	.3158	.51	22.75	526.9	549.6	1.077	0.566
	53	513	94.01	79.31	3.109	.3217	.44	23.90	526.0	549.9	1.075	0.567
	54	514	95.81	81.11	3.052	.3277	.38	25.05	525.0	550.1	1.072	0.569
	55	515	97.64	82.94	2.996	.3338	38.31	26.21	524.1	550.3	1.071	0.570
	56	516	99.50	84.80	2.941	.3400	.25	27.36	523.2	550.5	1.069	0.571
	57	517	101.38	86.68	2.887	.3463	.18	28.52	522.2	550.7	1.067	0.572
	58	518	103.29	88.59	2.835	.3527	.12	29.68	521.2	551.0	1.066	0.573
	59	519	105.23	90.53	2.784	.3592	.05	30.83	520.3	551.2	1.064	0.574

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	Degrees Fahr.	Absolute.	Absolute.	Gauge.	Volume in Cubic Feet per Lb.	Weight in Lbs. per Cubic Foot	Weight in Lbs. per Cubic Foot				
	t	T	p	p'	v	$\frac{1}{v}$	s	q	r	H	N	cp
	80	540	153.19	138.49	1.926	.5193	36.74	55.47	499.4	554.9	1.033	0.598
	81	541	155.82	141.12	1.894	.5281	.68	56.66	498.4	555.1	1.031	0.599
	82	542	158.49	143.79	1.862	.5370	.62	57.85	497.4	555.2	1.030	0.600
	83	543	161.19	146.49	1.831	.5460	.56	59.04	496.3	555.4	1.028	0.601
	84	544	163.93	149.23	1.801	.5551	.50	60.23	495.3	555.5	1.027	0.602
	85	545	166.70	152.00	1.772	.5643	36.44	61.43	494.2	555.6	1.025	0.604
	86	546	169.50	154.80	1.743	.5737	.39	62.62	493.1	555.8	1.024	0.605
	87	547	172.34	157.64	1.714	.5832	.33	63.82	492.1	555.9	1.023	0.606
	88	548	175.22	160.52	1.686	.5928	.27	65.02	491.0	556.0	1.021	0.607
	89	549	178.13	163.43	1.659	.6025	.21	66.22	489.9	556.2	1.020	0.609
	90	550	181.08	166.38	1.633	.6123	36.15	67.42	488.9	556.3	1.018	0.610
	91	551	184.07	169.37	1.607	.6222	.10	68.62	487.8	556.4	1.017	0.611
	92	552	187.09	172.39	1.581	.6323	36.04	69.82	486.7	556.5	1.015	0.612
	93	553	190.15	175.45	1.556	.6425	35.98	71.03	485.6	556.6	1.014	0.613
	94	554	193.20	178.50	1.532	.6529	.92	72.23	484.5	556.7	1.013	0.615
	95	555	196.40	181.70	1.508	.6634	35.86	73.44	483.4	556.8	1.011	0.616
	96	556	199.59	184.89	1.484	.6741	.81	74.65	482.3	557.0	1.010	0.617
	97	557	202.82	188.12	1.460	.6849	.75	75.86	481.2	557.1	1.008	0.619
	98	558	206.09	191.39	1.437	.6959	.70	77.07	480.1	557.2	1.007	0.620
	99	559	209.40	194.70	1.416	.7070	.63	78.28	479.0	557.3	1.005	0.621

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

TABLE I—LAMP VALUES

Kinds of Filaments	Horizontal or Nominal C.P.	Watts	Light Units (Lumens)	Multiplying Factor
Carbon	2	10	21	4.59
Carbon	*4	20	50	3.84
Carbon	*8	30	96	3.02
Candelabra Carbon	8	31.1	96	3.10
Gem	20	50	207	2.31
Gem	32	80	337	2.28
Tungsten (Mazda)	7.7	10	76	1.26
"	12.0	15	118	1.22
"	17.1	20	168	1.14
"	21.9	25	215	1.12
"	36.4	40	357	1.08
"	56.0	60	549	1.05
"	98.0	100	960	1.00
"	167.0	150	1637	.882
"	278.0	250	2723	.882
"	445.0	400	4535	.847
"	556.0	500	5665	.847

TABEL III—DESIRABLE SIZES OF SQUARES FOR LIGHTING OUTLET

Kind of Room	Ceiling Height	Desirable length of side of Square
Armories	12—16	12—16
Auditoriums	12—16	12—16
Public Halls	over 16	15—26
Rinks	over 16	15—26
Stores	8—11	8—11
Stores	11—15	10—16
Stores	over 15	14—22
Offices with desk Lamps	10—20	12—18
Offices without desk Lamps	9—12	7—11
Offices without desk Lamps	12—16	9—14
Offices without desk Lamps	over 16	11—18

TABLE IV—WATTS PER SQUARE FOOT TO PRODUCE ONE FOOT CANDLE ILLUMINATION. (Watts per Lumen.)

Type of Lighting Equipment	Ceiling Light			Ceiling Medium			Ceiling Dark	
	Walls			Walls			Walls	
	Light	Medi'm	Dark	Light	Medi'm	Dark	Medium	Dark
Mirror (Bowl Type Direct)	.180	.186	.196	.183	.193	.196	.196	.196
Prismatic (Clear)	.180	.204	.208	.225	.240	.263	.263	.270
Prismatic (Satin Finish)	.230	.251	.277	.257	.277	.309	.309	.337
Prismatic (Velvet Finish)	.200	.220	.240	.220	.240	.251	.277	.284
Opal Enclosing Unit	.300	.327	.360	.384	.372	.416	.491	.540
Prismatic Enclosing Unit	.216	.235	.245	.240	.251	.284	.300	.309
Opal Reflector (Heavy Density)	.200	.208	.225	.216	.225	.235	.235	.235
Opal Reflector (Medium Density)	.216	.235	.251	.240	.251	.284	.292	.300
Opal Reflector (Light Density)	.229	.251	.277	.263	.277	.308	.318	.327
Enameled Steel (Dome Shaped)	.204	.216	.225	.208	.220	.225	.225	.225
Enameled Steel (Bowl Shaped)	.225	.235	.245	.229	.240	.245	.245	.245
Semi-Indirect	.251	.284	.318	.386	.415	.470	Not Recommended	
Indirect (Mirror Reflector)	.349	.386	.415	.514	.568	.635	Not Recommended	
Bare Lamp	.270	.309	.372	.309	.372	.432	.450	.514

COLOR CLASSIFICATION

Light	Medium	Dark
White	Yellow	Green
Cream	Light Buff	Red
Light Gray	Light Blue	Brown

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Degrees Fahr.	Absolute	Absolute.	Gauge.	Volume in Cubic Feet per Lb.	Weight in Lbs. per Cubic Foot	Weight in Lbs. per Cubic Foot					
t	T	p	p'	v	$\frac{1}{v}$	s	q	r	H	N	cp
100	560	212.75	**198.05**	**1.392**	.7183	35.58	79.50	**477.9**	557.3	1.004	0.623
101	561	216.15	**201.45**	**1.370**	.7297	.52	80.71	**476.7**	557.4	1.003	0.624
102	562	219.59	**204.89**	**1.349**	.7413	.46	81.93	**475.6**	557.5	1.001	0.625
103	563	223.07	**208.37**	**1.328**	.7530	.41	83.15	**474.5**	557.6	1.000	0.627
104	564	226.60	**211.90**	**1.307**	.7650	.35	84.37	**473.3**	557.7	0.998	0.628
105	565	229.5	**214.8**	**1.297**	.770	35.28	85.58	**472.3**	557.9	0.9953	0.630
106	566	232.5	**217.8**	**1.279**	.783	.21	86.80	**471.2**	558.0	0.9930	0.631
107	567	235.8	**221.1**	**1.261**	.794	.15	88.03	**470.0**	558.1	0.9906	0.633
108	568	239.1	**224.4**	**1.242**	.816	.10	89.26	**468.9**	558.2	0.9883	0.635
109	569	242.4	**227.7**	**1.224**	.828	.02	90.48	**467.8**	558.3	0.9861	0.636
110	570	246.0	**231.3**	**1.205**	.830	34.98	91.71	**466.6**	558.3	0.9837	0.638
111	571	249.6	**234.9**	**1.188**	.843	.94	92.93	**465.5**	558.4	0.9814	0.639
112	572	253.1	**238.4**	**1.170**	.856	.89	94.16	**464.3**	558.5	0.9792	0.640
113	573	256.6	**241.9**	**1.153**	.869	.83	95.38	**463.2**	558.6	0.9769	0.640
114	574	260.2	**245.5**	**1.135**	.882	.78	96.61	**462.2**	558.7	0.9746	0.641
116	576	269.1	**254.4**	**1.101**	.909	.68	99.07	**459.7**	558.8	0.9700	0.644
118	578	276.9	**262.2**	**1.067**	.938	.56	101.55	**457.3**	558.8	0.9653	0.647
120	580	285.1	**270.4**	**1.033**	.968	34.43	104.03	**454.9**	558.9	0.9606	0.650
122	582	294.0	**279.3**	**1.002**	0.999	.34	106.52	**452.4**	558.9	0.9560	0.653
124	584	302.9	**287.2**	**0.972**	1.030	.14	109.01	**450.0**	559.0	0.9515	0.656

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Degrees Fahr.	Absolute.	Absolute.	Gauge.	Volume in Cubic Feet per Lb	Weight in Lbs. per Cubic Foot	Weight in Lbs. per Cubic Foot					
t	T	p	p'	v	$\frac{1}{v}$	s	q	r	H	N	cp
60	520	107.20	**92.50**	**2.734**	.3658	37.99	31.99	**519.4**	551.4	1.063	0.575
61	521	109.21	**94.51**	**2.685**	.3724	.92	33.15	**518.4**	551.6	0.061	0.576
62	522	111.26	**96.56**	**2.637**	.3792	.86	34.31	**517.5**	551.8	1.060	0.577
63	523	113.34	**98.64**	**2.590**	.3861	.80	35.48	**516.5**	552.0	1.058	0.578
64	524	115.45	**100.75**	**2.544**	.3931	.73	36.64	**515.5**	552.2	1.057	0.579
65	525	117.59	**102.89**	**2.499**	.4002	37.67	37.81	**514.6**	552.4	1.055	0.580
66	526	119.76	**105.06**	**2.455**	.4074	.61	38.97	**513.6**	552.6	1.054	0.582
67	527	121.96	**107.26**	**2.411**	.4147	.55	40.14	**512.6**	552.7	1.052	0.583
68	528	124.20	**109.50**	**2.369**	.4221	.48	41.31	**511.6**	552.9	1.051	0.584
69	529	126.44	**111.74**	**2.328**	.4296	.42	42.48	**510.6**	553.1	1.049	0.585
70	530	128.72	**114.02**	**2.288**	.4372	37.36	43.66	**509.6**	553.3	1.048	0.586
71	531	131.03	**116.33**	**2.248**	.4449	.29	44.83	**508.6**	553.5	1.046	0.587
72	532	133.37	**118.67**	**2.209**	.4527	.23	46.01	**507.6**	553.6	1.045	0.588
73	533	135.74	**121.04**	**2.171**	.4606	.17	47.19	**506.6**	553.8	1.043	0.589
74	534	138.14	**123.44**	**2.133**	.4686	.11	48.37	**505.6**	554.0	1.042	0.591
75	535	140.57	**125.87**	**2.097**	.4768	37.03	49.55	**504.6**	554.1	1.040	0.592
76	536	143.03	**128.33**	**2.061**	.4851	36.99	50.73	**503.6**	554.3	1.039	0.593
77	537	145.52	**130.82**	**2.026**	.4935	.93	51.91	**502.5**	554.3	1.037	0.594
78	538	148.04	**133.34**	**1.992**	.5020	.86	53.10	**501.5**	554.6	1.036	0.595
79	539	150.60	**135.90**	**1.959**	.5106	.80	54.28	**500.5**	554.8	1.034	0.596

Besides the separators described above, the Elliott Co., of Pittsburgh, Pa., also makes a complete line of steam separators which have been redesigned to meet the specifications for flanges recently adopted. In Fig. 5, is shown type AH, which is adaptable for use in vertical pipes where the pressure is 250 lb. per square inch. For pressures up to 125 lb. per square inch, type AL (not illustrated) is recommended for vertical pipe, the principle upon which it works is practically the same as that of type AH, but the construction is not so strong.

Types CL and CH are for horizontal pipe, and are built respectively for 125 and 250 lb. per square inch. All of these steam separators are built with large steam space so as not to reduce the pressure, and at the same time act as receivers to maintain as nearly as possible a constant pressure at the cylinder where reciprocating engines are used.

Catalog Notes

THE POWELL "White Star" valve booklet was recently received and can be obtained by addressing The Wm. Powell Co., Cincinnati, O.

CATALOG A from The Hilliard Clutch and Machinery Co., Elmira, N. Y., describes and illustrates the Hilliard friction clutch and cutoff coupling.

CIRCULAR AC8, describing the Gardner one-tool plant for monumental work, was recently issued by The Gardner Governor Co., Quincy, Ill.

STOP THE ENGINE is the title of a pamphlet relating to the Locke engine stop and speed limit system, manufactured by The Locke Regulator Co., Salem, Mass.

HORIZONTAL, double-acting, single-cylinder power pumps are described and illustrated in Catalog D224, from The Deane Steam Pump Co., 115 Broadway, New York.

REDUCING COAL CONSUMPTION and Increasing the Efficiency of the Power Plant is the subject of a booklet illustrating the use of "Lea" V-notch waterflow recorders. These instruments are made by Yarnall-Waring Co., Philadelphia.

THE NEW EDITION of The Simplex Manual, published by the Simplex Wire & Cable Co., Boston, is ready for distribution to anyone who asks for it. The 92 pages of tables and other information about insulated conductors are served by a very complete index.

HAWKES BOILER CO., Marquette Bldg., Chicago, has lately issued a 36-page catalog describing the Hawkes boiler and giving tables of efficiency, coal cost of steam, approximate composition and calorific value of typical American coals.

BULLETIN No. A4143, recently issued by the General Electric Co., is devoted to that company's belt-driven alternators, knowns as Form B, and supersedes the previous bulletin on this subject. Bulletin No. A4189, devoted to small plant direct-current 3-wire switchboards of 125 and 250 volts and 10 to 100 kw., supersedes the previous bulletin on this subject.

WESTINGHOUSE PORTABLE METERS (Circular 1104) is the title of a rather elaborate publication just issued by the Westinghouse Electric & Mfg. Co., describing its complete line of portable instruments. A number of detail and complete photographs are shown, together with various diagrams.

CATALOG SECTION DS843, covering catenary line material has just been issued by the Westinghouse Electric & Mfg. Co. The publication describes and illustrates with considerable detail the different types of insulators, hangers, strainers, etc., together with diagrams showing the spacing for wheel trolleys and pantagraph trolleys.

"HEATING AND VENTILATING a Large Factory" and "Heat Transmission through Building Walls of Corrugated Iron" are the titles of 2 articles which the Green Fuel Economizer Co., of Matteawan, N. Y., has printed for gratuitous distribution. The actual heat transmission found is compared with figures deduced from various data and formulas with which it is found in substantial agreement. The details of construction of the building are fully described and the general arrangement of apparatus, exposure of the building, etc., are shown by drawings and photographs.

A 36-PAGE PAMPHLET has just been issued by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa., as an introduction to its general separator catalog. It discusses the economies of using steam and oil separators, the insurance value of separators, the mechanism of separating oil and water from steam, the efficiency of and tests on separators, etc. The recommendation is made that a separator be placed between boiler and superheater, in order to prevent the accumulation of scale in the latter, which may come about from priming of the boilers.

THE GENERAL ELECTRIC CO. is just distributing its annual catalog of Electric Fans, illustrating and describing the company's fans for the season of 1914. While technical data have intentionally been omitted, the catalog contains sufficient information to enable customers to order intelligently. The publication is devoted to fans for table, wall and ceiling mounting, and describes also small ventilating outfits. Among the first mentioned are fans which are moisture-proof and have fittings which are noncorrosive. These are especially for use on ship-board. The number of the bulletin is A4197.

BALDWIN-WESTINGHOUSE Electric Mine Locomotives is the title of a pamphlet which has just been issued by the Westinghouse Electric & Mfg. Co., at East Pittsburgh, Pa., and the Baldwin Locomotive Works, at Philadelphia. The pamphlet describes fully the construction of the modern electric locomotive and a large number of views are given showing the construction details. The new barsteel frame locomotive is described and illustrated, and its advantages pointed out. The various accessories, such as controllers, circuit breakers, trolleys and gathering reels are also described and illustrated. Specification blanks for mine haulage locomotives are also included.

C. C. WILEY, Associate, and G. W. Pickles, Instructor in the Department of Civil Engineering of the University of Illinois, have collaborated in the preparation of a comprehensive textbook on Railroad Surveying, which has just been published by John Wiley and Sons, New York City. The volume contains 263 pages and brings up to the present the best practice in railroad surveying. The need of a work covering modern methods has been felt for many years, and this textbook fills the need admirably.

Trade Notes

THE WESTINGHOUSE Electric & Mfg. Co. reports the receipt of an order from the Nevada Cinnabar Co., Ione, Nevada, for electrical equipment consisting of a 50-kva. generator and motors for operating pumps, crusher, elevator, fans, etc. This is the first electrically driven mercury mine in Nevada.

THE SUPERIOR Water, Light and Power Co. has just finished installing the following new equipment in its Superior plant to run as an emergency helper in times of low water at Great Northern Power Co. hydraulic plant at Thompson, Minn. A Westinghouse Parsons steam turbine generator rated at 1500 kva., 2300 volts, 377 amp. per terminal, 3 phase generator, 60 cycle at 3600 r.p.m. Excitation is by a d.c. generator of 15 k.w. capacity, 125 volts, 120 amp. at 36 r.p.m.

THE SUPERIOR LAUNDRY Co. has just started up its new Lyons combination water and fire tube boiler of 120 rated horsepower. This laundry has all motor driven machinery and has purchased a direct connected Ideal engine but this is not yet installed.

ON ACCOUNT OF a large increase in business, Sales Manager Sabin, of Nashua Machine Co., Nashua, N. H., has increased his office force and doubled the size of the Boston office, but has not changed its location, continuing at the former address, 127 Federal Street, Boston, Mass.

THE INSULATION DEPARTMENT of the Armstrong Cork Co. has been taken over and will hereafter be conducted by the Armstrong Cork & Insulation Co. The personnel of the management and the sales force will be the same as heretofore. The growing importance of the insulation business and the recent addition to this line, of steam pipe and boiler coverings (which contain no cork), rendered it desirable to make this change for the more satisfactory and efficient transaction of the company's business.

LACLEDE-CHRISTY Clay Products Co., of St. Louis, has recently received orders for Laclede-Christy chain grate stokers, as follows: Commonwealth Steel Co., Granite City, Ill., stokers for 5 35-hp. boilers; St. Joseph Lead Co., Bonne Terre, Mo., stokers for 10 300-hp. boilers; Federal Lead Co., Leadwood, Mo., stokers for 3 400 and 1 600-hp. boilers; Indianapolis Water Co., Indianapolis, Ind. (3rd order), stokers for 2 250-hp. boilers; Staley Mfg. Co., Decatur, Ill. (3rd order), stokers for 2 550-hp. boilers; Kentucky Distillery & Warehouse Co., Louisville, Ky., stokers for 4 460-hp. boilers; Artificial Ice & Cold Storage Co., Indianapolis, Ind. (repeat order), stokers for 2 250-hp. boilers; Peoples' Ice & Cold Storage Co., Omaha, Nebr., stokers for 1 300 and 3 200-hp. boilers.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

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Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.
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Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $60.00.
Half page, one year, each insertion, $35.00.
Quarter page, one year, each insertion, $20.00.
Eighth page, one year, each insertion, $12.00.
Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used but no heavy black and white plates.

Invoices are rendered monthly and subject to 2 per cent discount within 10 days.

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Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,500

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—Chief engineer of wide experience in large plants; with first class license for Ohio and chief from U. S. Government for Marine Engineer. Solicits correspondence from large manufacturing concerns in view of locating with same. Address C. E. Hardy, 247 Forer St., Lockland, Ohio. 2-15-2

POSITION WANTED—In light or power plant, with chance for advancement. A. S. C. student. Age 20. Some experience with steam. References. Fred Mertens, Jr., Box 311, Gladbrook, Iowa. 2-15-1

POSITION WANTED—By stationary steam engineer with 8 years' experience; wants position with some good company. Can furnish the best of reference as to ability and character. Wire at my expense. Harry Mendenhall, Geary, Okla. 2-15-1

POSITION WANTED—As engineer in a small plant. Have run Corliss engine and D.C. generator. Can furnish good references. Salary $100. Address Box 334, Practical Engineer. 2-15-1

POSITION WANTED—By technical engineer with over 9 years' experience with all kinds of pumping machinery. 6 years with N. S. Soot, steam, gas and steam fitter. Address Box 148, Crawford, Nebr. 2-15-1

Wanted

IF YOU RECOGNIZE the value of approved specialties in an engine and boiler room as a means of higher efficiency; if you believe in this sort of thing to the extent that you think you could sell a well known boiler specialty in your territory for an old established manufacturer in the power-plant field, write and tell us all about yourself. On receipt of your letter we will outline our proposition in full. Address Box 324, Practical Engineer. tf.

MANUFACTURER desiring high-grade, direct representation in Cleveland territory, may secure the services of a salesman experienced with well known engines, air compressors and power-plant equipment. Other lines will be considered. Highest business and character references. Address Box 336, Practical Engineer. 2-15-1

WANTED—Every local Engineers' Association to have an assortment of valuable power-plant books—Secretary write at once, for full particulars. Address Dept. C., Practical Engineer, Chicago.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

SALESMAN of 12 years' experience with steam equipment desires one or two additional lines to push in Northern Ohio. Excellent references. Address Box 335, Practical Engineer. 2-15-1

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

Help Wanted

WANTED—An additional subscription solicitor wanted to cover towns in the state of Indiana. Excellent chance to earn extra money. Write to Subscription Department. tf.

For Sale

USE AN AIR-FRICTION with new, 1914 improvements. Increases power and economy of motor one-half. Absolutely impossible to choke or load. Uses distillate, gasoline or half kerosene with finest results. Starts easy in coldest weather. We fit all motors, guaranteeing definite results or refund money. Exclusive county rights. Liberal exchange on other carburetors. The Air-Friction Carburetor Co., Dayton, Ohio. 2-15-6

DIRECT-CONNECTED GAS Units—100-kw. Westinghouse 250-volt generator, with Westinghouse 3-cylinder gas engine, $2,500. 75-kw. Crocker Wheeler 250-volt generator, with Nash 3-cylinder gas engine, $2,000. 50-kw. Westinghouse 125-volt generator, with Westinghouse 3-cylinder gas engine, $1,350. Duzets & Son, 50 Church St., New York. Send for complete "Bargain List." 2-1-2

FOR SALE—Two 250-kw. Rotary Converters, type E. C., form E, class 6-250-500, 500 r.p.m., 600 volts, d.c.; d.c. amperes 416; a.c. end, 25 cycles, 3 phase, 360 volts. These machines are in A-1 condition and can be delivered at once. Price $1,400 each, f.o.b. cars (Penna. delivery). F. H. Herring, Inc., 30 Church St., New York. 2-15-6

FOR SALE—14 by 42 Wheelock Engine; wheel 9 ft. by 20 ins. Also Bulkley Condenser in first-class condition, and National Heater with double coil, back-pressure valve and exhaust head. Address M. Heminway & Sons Silk Co., Watertown, Conn. 2-1-2

ENGINEERS' transits and levels, slightly used, good bargains. W. F. Sprengnether Instrument Co., 205 Ozark Bldg., St. Louis, Mo. 2-15-2

FOR SALE—Good paying electric light plant in lively town in western part of Missouri; good reason for selling. Adrian Electric Light & Power Company, Adrian, Mo. 2-15-2

OUR MODERN BLUE PRINT CHART method of electrical wiring. Write for information. Electrical Wiring Diagram Co., Box F173, Altoona, Pa. 11-15-12

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS SECURED or fee returned—Send sketch for free expert search and report as to patentability. Books on inventions and patents, and reference book sent free. John S. Duffie & Co., 607 F St., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F. St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.

PATENT WHAT YOU INVENT. It may be valuable. Write me. No attorney's fee until patent is allowed. Estab., 1882. "Inventor's Guide" FREE. Franklin H. Hough, 357 Loan & Trust Bldg., Washington, D. C. 2-1-2

PATENTS SECURED—Legal protection our specialty. Booklet free. Harry Patton Co., Suite 330, McGill Bldg., Washington, D. C. tf.

OFFICIAL DRAWINGS FREE. Patents procured or fee returned. Expert services. Send sketch for Free search. The Patent Exchange, Garban Bldg., Washington, D. C. tf.

AMERICAN AND FOREIGN PATENTS obtained. Prompt, persevering, reliable service. Book free. W. X. Stevens, 58 Adams St., Washington, D. C. 2-15-2

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

PROF. ARTHUR BATEMAN, who has been a practical teacher for 11 years, in 4 different institutions, in 2 countries, teaches by mail Sanitary Engineering, Sanitary Inspection, Plumbing, Hygiene. Booklet free. Write Desk 2, Anglo-American Sanitary Correspondence College, 12 W. Ontario St., Chicago, Ill. 1-1-4

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in one new subscription to Practical Engineer. Gilt edges; bound in leather.

Technical Books

BOOKS ABOUT ELEVATORS—Best published. W. A. Morse, 19 Union Place, Yonkers, N. Y. 2-15-6

Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks From The Advertising Pages

A recent advertisement in Practical Engineer brought out a good point in its opening sentence: "There is often more to our advertisements than the mere dry technical side. There is food for thought in such letters as the one we recently published from an Engineer in far-off, fever-stricken Africa."

Did you ever give a thought to the romance, wealth and accomplishment which are interwoven with the advertising of the last two decades? Could it, by some means, be revealed, the wonderfully imaginative creations of Stevenson, Haggard, Corelli would be outdone by the *actual.*

The newspapers of a few weeks ago told us how a little few-line want ad was really back of the big Mississippi River Power Plant at Keokuk, Iowa. It attracted the attention of an engineer who had done big things. He got the job offered through the want ad, and eventually conceived and finished this mighty undertaking.

A man and his brother in an Ohio City quarreled over the amount of money to be spent in advertising their product. They dissolved partnership and one brother put all the money he had into advertising. Today, the principal building in the city bears his name and a private street railway line runs from the city to his home.

A few years ago the residents of a certain section of New York were visited by a man selling an oil of superior qualities which he manufactured. He inherited $100.00—spent it for advertising. That was the beginning of a bigger field. Now you can buy his product in the smallest hamlet.

We wonder how many of our readers have remembered the many unusual happenings or "news stories" recorded in late advertisements in Practical Engineer.

Partial review brings to mind the stories of pipe threading 300 feet beneath the busiest street in America; of shooting an oil well where more than 300 lbs. of nitroglycerine failed to fracture a piece of pipe accidently left in the hole; of how an American-made generator is working in sight of a famous mountain in a country rated as unfriendly to America; of an accident to the governor of a huge refrigerating machine where danger was prevented by a simple cutoff valve; of a gage glass standing the wild ride of 12,129 miles in a rolling, vibrating locomotive; and of a piece of transmission rope pulling a load of 700 hp. over a distance of 997,920 miles.

Advertising men look for stories connected with their products. Any story that rings true and creates interest is good advertising for them.

We know of many men who turn to the Advertising Pages before they read the editorial pages. We do not know that it is necessary to go to this extreme, but everyone interested in the developments of power-plant machinery should read the a d v e r t i s i n g pages of Practical Engineer.

Read them for mental development, economy and for THE INTEREST FOUND THERE.